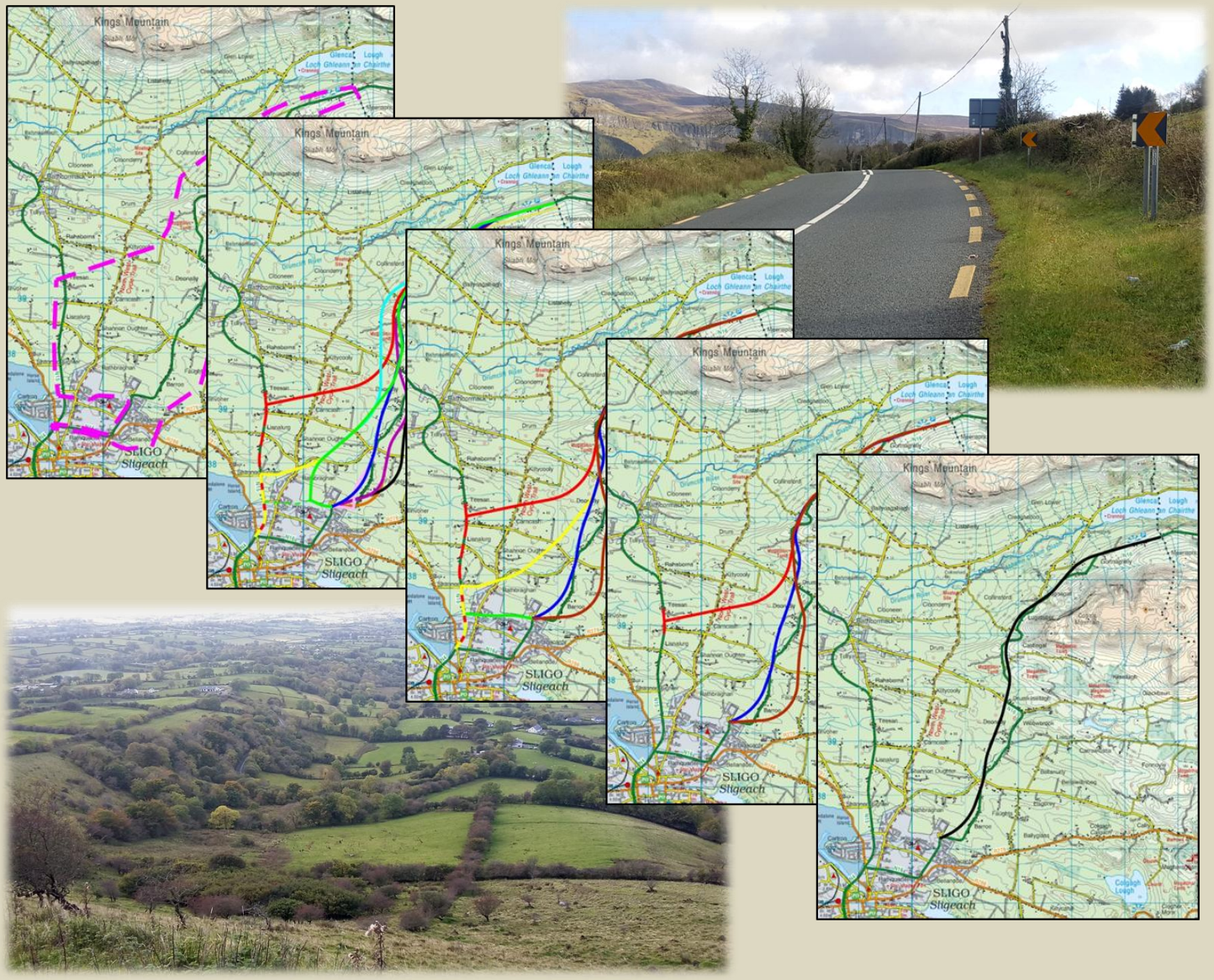
Route Selection Report

Volume 1: Main Report

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

N16 Sligo to County Boundary



Land of Hearts Desire

SLIGO COUNTY COUNCIL

TII
Bonneagar Iompair Éireann
Transport Infrastructure Ireland

i. PREFACE

THIS ROUTE SELECTION REPORT CONSISTS OF THE FOLLOWING DOCUMENTS:

Volume 1

- **MAIN REPORT**

Volume 2

- Engineering appendices:
  - PART A: Traffic & Transport Assessment;
  - Part B: Road Engineering, Road Safety Impact Assessment and Options Comparison Estimate);

Volume 3

- Environmental appendices:
  - PART A: Human Environment (including Urban Planning);
  - PART B: The Natural Environment;
  - PART C: Landscape & Visual, and Cultural Heritage;

Volume 4

- Road Safety Audit Stage F;

Volume 5

- Figures;

Volume 6

- Stage 2, Project Appraisal, Multi Criteria Analysis;

Document Control

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Status	Issued For	Signed	Date	Approved
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Table 1-1: N16 Sligo to County Boundary Route Selection Team

Study/Element	Body Responsible
Design	SCC National Road Design Office
Engineering	
Assessment Coordination, Multi Criteria Analysis and Report Compilation.	
Project Liaison.	
Road Safety Impact Assessment	
Traffic Modelling	Jacobs Engineering
Stage F Road Safety Audit	Kerry and Donegal NRDO's
Economic Appraisal (Stage 2 – Project Appraisal)	Jacobs Engineering
Landscape & Visual	RPS Ireland Ltd.
Flora, Fauna & Fisheries	RPS Ireland Ltd. With input from Denyer Ecology.
Agricultural and Non-Agricultural Property	John Bligh & Associates
Noise & Vibration	Envest Environmental
Air Quality & Climate Change	Envest Environmental
Hydrology & Hydrogeology	Hydro Environmental (Galway)
Soils & Geology	Roughan & O'Donovan
Socio Economic	Optimize Consulting
Archaeology & Cultural Heritage	ASCU
Architectural Heritage	ASCU
Impacts on Sligo & Environs Development Plan	The Planning Partnership

Design

Sligo County Councils National Roads Project Office is responsible for the design of the various route options contained within this Route Selection Report.

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ii. EXECUTIVE SUMMARY

1 Executive Summary[3]

1.1 Context

The purpose of this Route Selection Report is to establish a Preferred Route for the N16 within County Sligo. The Emerging Preferred Route which is presented in this Route Selection Report shall enable and guide the design of minor schemes along the N16 over the coming years.

The route selection and appraisal process assesses the routes in their entirety, in order to accurately compare the various alternatives and to facilitate sustainable and long term proper planning. This should not be interpreted in any way, as meaning that the route may be developed as one single linear project.

This Route Selection Report now supersedes a previous Route Selection Assessment undertaken in 1996. The need for the update was due to numerous factors including *inter-alia*: requirements set out in the TII/NRA Project Management Guidelines; post 1996 changes in terms of the proposed strategic road network in Sligo, including the N15 Sligo to County Boundary Route Corridor and the Eastern Garvogue Bridge; advancements in terms of traffic analysis and modelling; more stringent requirements in terms of Project Appraisal; and, changes to planning and environmental legislation.

1.1 Existing Conditions on the National Route

The existing road network in the area is multi-functional and is required to cater for conflicting demands, including accommodating long distance through traffic and locally generated trips.

The route, as it occurs within County Sligo, can be divided into two relatively contrasting sections. The 1.9km section from the N15 near Hughes bridge along Ash Lane past Sligo Institute of Technology as far as the AbbVie Roundabout, is subject to a 50kph speed limit and can be classified as urban in nature. The remaining section (8.5km) of the route is rural in nature and is subject to a 100kph speed limit, it contains sporadic roadside housing development, particularly in the section closer to City.

On the rural section of the route there are approximately eleven clusters of houses (2 or more property entrances) with direct access to the national primary route. The most significant of these clusters occur at *Barroe*, *Doonally* and *Lugatober* townlands. In addition, the route is populated with additional direct house and agricultural entrances.

The entire rural section has a substandard cross section coupled with a grossly inadequate vertical and horizontal alignment. This is predominately due to the topography of the area which could be described as hilly to mountainous. Consequently, from *Doonally* townland northwards the road follows a winding somewhat tortuous route around the slope of Copes mountain from an elevation of less than circa (c.) 50m O.D. at *Doonally* to c. 130m O.D. at the Leitrim Boundary.

The urban section between the junction with the N4/N15 and the AbbVie Roundabout is generally of good standard.

There are a significant number of junctions (23) with local roads along the existing route. Safety issues in relation to these junctions include junction location and inadequate Stopping Sight Distance.

[3] The following section of the Route Selection Report provides a brief overview of the Route Selection process. The main report and its appendices should be referred to, for a fuller appreciation of the study.

1.2 Need for the Scheme

At a policy and strategic level, there is a clear need for an upgrade to the existing N16, which is repeated in numerous International, National and Regional Development Policies. These are expanded upon in section 3.2 of this Route Selection Report and include *inter-alia*:

- TEN-T Trans European Transport Network;
- National Spatial Strategy for Ireland 2002-2020: People, Places and Potential[4];
- Regional Planning Guidelines for the Border region, 2010-2022;
- Border, Midlands and Western Regional Operational Programme, EU Regional Policy, 2007-2013;
- Smarter Travel, a Sustainable Transport Future, 2009-2020;
- Implementing the NSS: Gateway Investment Priorities Study, 2006; and
- Forfás Regional Competiveness Agenda, 2010;
- Investing in our Transport Future, Strategic Investment Framework for Land Transport;
- Sligo County Development Plan.

Numerous studies commissioned by various organisations including *inter-alia:* Transport Infrastructure Ireland (formerly NRA), Irish Central Border Area Network (ICBAN), North West Region Cross Border Group (NWRCBG) and the various Regional Local Authorities have identified the significant deficiencies and the 'Needs' for upgrading of the N16. These reports (which are expanded upon in section 3.2.8 of the Main Report), in conjunction with scheme specific assessments outlined in this Route Selection Report establish the following recurring themes:

- Average journey times on this route are significantly lower than journey times on other national primary routes (this has significant effects on journey times from Sligo to Belfast);
- There is an under investment in transport infrastructure in the regional area;
- The geometry is significantly deficient for a national primary route;
- A strategic core East-West Route is best served by a corridor through Sligo-Enniskillen-Dundalk;
- Infrastructural investment on both sides of the border has been dictated by the policies set out in the respective national strategies, and is driven primarily by a desire to link the major population centres within the respective jurisdictions as a first phase, extending to linking population centres across the Island as a second stage. Furthermore, the two strategies are have not historically been integrated on a cross-border basis. This has had a significant effect on any planned upgrades to the N16 in the past;
- There is, according to a number of studies, a close correlation between the standard of a region's transport infrastructure and its development status; internationally, a poor transport infrastructure has been shown to have a major inhibiting impact on investment and both economic and social development, including in the areas of the quality of life, access to both fundamental and specialist amenities, international access and access to major local and national social events;
- The Gateways and Hubs identified in the National Spatial Strategy, other than Dublin, have benefitted substantially in terms of improved employment accessibility. However, Sligo is a notable exception due in part to the lack of significant upgrades to its national road networks.

[4] To be succeeded by the National Planning Framework

1.3 Scheme Objectives

The overarching objective in relation to the N16 is to align the design speed of the N16 with national standards and in so doing to ...*secure the provision of a safe and efficient network of national roads...* as is required in the Roads Act.

As the route selection process evolved and the number of viable route options reduced, the intensity and scale of the assessment increased.

In the Stage 1, Preliminary Options Assessment (sections 9 and 10 of this Route Selection Report) the objectives were measured under the headings of Engineering, Economics and Safety as recommended by the TII Project Appraisal Guidelines and the Project Management Guidelines.

In Stage 2 (Project Appraisal), the objectives of the scheme were appraised in accordance with the national transport planning policy, using the common appraisal framework and the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

Economy

The N16 is a key national and cross border corridor and delays to traffic have a negative impact upon the economy. The economy objective is concerned with improving the economic efficiency of transport and providing economic transport solutions.

It is an objective of the proposal to decrease average journey times in order to achieve a Level of Service D in the design year. A Level of Service D, approximately equates to an average inter-urban speed of 80 km/h. This will reduce journey times and improve journey time reliability, both of which will generate positive economic benefits to businesses and consumers.

Economic efficiency and effectiveness is measured by the willingness-to-pay of the consumer, the financial impact on transport providers and the effects on government finance. These factors are captured through Cost Benefit Analysis (CBA). CBA analyses how projects could increase overall welfare, after allowing for economic costs. If Benefits exceed Costs, or if the Benefits/Costs ratio exceeds 1, then the project should add to overall welfare of society.

The key measure of Efficiency and Effectiveness to be used in the Multi Criteria Analysis (MCA) is the transport user related Present Value of Benefits (PVB).

Safety

The safety objective aims to reduce loss of life, injuries and damage to properties resulting from transport collisions.

It is an objective of the route corridor improvement to replace the existing deficient section of the N16 with a Type 2 Single Carriageway, consistent with the standards set out in the TII Design Manual for Roads & Bridges. It is also proposed, to as far as is possible, segregate and reduce the number of direct accesses onto the route and to ensure the safe provision of facilities for Non-Motorised Users.

This will reduce the accident rate by improving the existing geometry which is significantly deficient.

Environment

The realignment of a road corridor, by its nature will have impacts on the existing environment. It will be an objective of the proposal to maintain these impacts, to as an acceptable level as is possible, while still achieving other objectives.

It will also be an objective of the proposal to improve the existing environment where that is possible. This will include *inter-alia:* improved water quantity and quality treatment measures, improved amenity benefits for those properties in the vicinity of the existing N16 and improved amenity benefits for vulnerable road users.

Accessibility and Social Inclusion

The proposal will improve road based public transport at a local, regional and national level, by improving safety along this section of the N16 corridor.

The project will seek to improve facilities for those without a car and to reduce access severance.

Integration

Integration aims to ensure that all decisions are taken in the context of wider European directives and national government policy objectives, and the impact of a scheme in terms of transport provision (e.g. provision of missing links), land use integration (e.g. compatibility with national / local land use strategies) and geographic integration (e.g. does the scheme improve transport links to Northern Ireland and Europe).

It is an objective of the proposal to improve existing connections to regional hubs and gateways. This will support the objectives of the National Spatial Strategy in terms of achieving balanced regional development. Additionally, the EU has designated the N16 as part of the comprehensive network of routes which support the core network of the Trans European Road Network. In this regard, improvements to the N16 will support the objectives of the TENT.

Physical Activity

The proposal, via the provision of dedicated cycle/pedestrian tracks (whether online or offline) will provide a positive benefit for pedestrians and cyclists who will utilise the services provided.

1.4 Constraints

One of the initial steps in the Route Selection Process was to identify the nature and extent of significant constraints within a defined Study Area.

The Constraints Study phase of the project is concerned with gathering together as much information as possible relating to the area of interest. The data collection was focused on determining what constraints exist which could influence the choice of route location for the proposed scheme.

The Constraints within the study area are expanded upon within sections 5 and 9 of this Report. In general however, some key constraints include:

- The existing urban and rural built environment;
- The ground topography particularly to the north of the L-3406-0 (Drum Road) which can be described as hilly to mountainous;

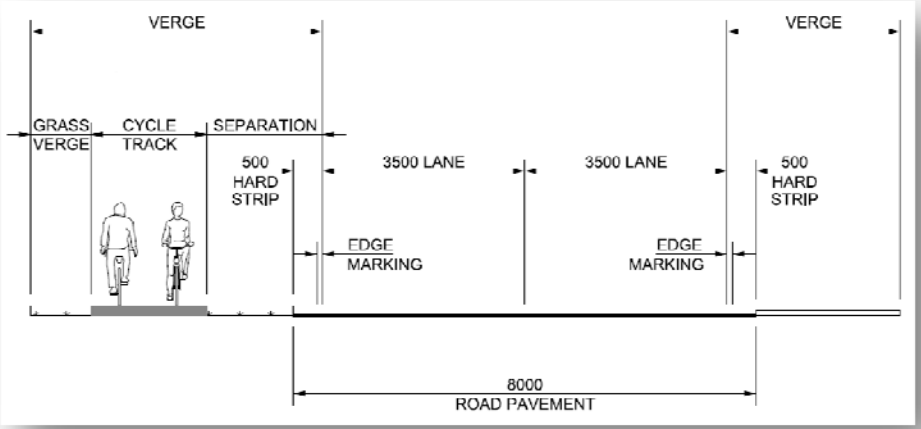
- Sensitive Landscape Character areas including; the Copes Mountain Upland Landscape Character Area which is determined to fall within the category of a 'Highest Quality' landscape and Glencar Lake Valley which is considered to be a 'Very Attractive' landscape;
- Designated ecological sites proximate to the study area including in particular Crochauns/Keelogyboy Bogs NHA (002435), Sligo Leitrim Uplands SPA (004187), and Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623);
- Undesignated ecological sites considered to be of national and county importance, including Lugnagall Flush, Gortnagrelly Wet Woodland and Tufa Springs, and West of Castlegal Tufa Springs;
- The existing road network including the N16 itself, which by its twisty nature makes realignment difficult;
- Various Archaeological, Architectural and Cultural Heritage Sites;
- Land Use including zoned lands in the Sligo & Environs Development Plan;

1.5 The Road Type

1.5.1 Cross Section

The cross section proposed for the Emerging Preferred Route corresponds to a Type 2 Single Carriageway arrangement as outlined in Figure 1-1. This arrangement will include provision for cycle tracks where alternative off road routes are not available.

Figure 1-1: Type 2 Single Carriageway



1.5.2 Junction Strategy

The junction strategy will be influenced by projected traffic volumes, however for the purposes of Initial Sketch Arrangement (at Route Selection Stage) and in accordance with the DMRB (DN-GEO-03060), the junction types are currently proposed to be:

- Simple T Junctions, or, staggered Right – Left junctions, for side road traffic with less than 600 AADT. This arrangement may be supplemented with Ghost Islands in certain areas;
- Roundabouts for:
  - Change in cross section;
  - Tie in points to the urban area;

Figure 1-2: DN-GEO-03060 ; Simple T Junction

Figure 1-3: DN-GEO-03060; Simple T Junction with Right/Left Stagger

1.5.3 Treatment of Direct Accesses (lightly trafficked and minor junctions)

The treatment of direct accesses has not been considered at Route Selection Stage; however, the following paragraph outlines the design objectives which will be sought at the next stage of the design process.

TII DMRB DN-GEO-03060 provides guidance in relation to the treatment of direct accesses and minor junctions:

> *The overriding principle is that direct vehicular access onto national roads shall be avoided as far as practicable.*

The design process for the N16 will adopt this approach, insofar as is reasonably practicable. The incorporation of these accesses into side roads, via the potential provision of parallel tracks, will concentrate turning movements onto and off the proposed N16, thereby improving safety aspects and Full Overtaking Sight Distance on the mainline.

Notwithstanding the foregoing, it should be noted, that each direct access arrangement will be considered on a case-by-case basis. There may be instances where it is impracticable, or where significant engineering works (via the provision of parallel tracks) makes the collection (to the local network) of some of these accesses unviable.

The case-by-case basis will focus on *inter-alia*:

- Journey Time and Community Severance;
- Value Engineering; and
- Safety.

1.6 The Consideration of Alternatives

The range of alternatives considered, can generally be classified under the following headings:

- Pre Constraints Study Alternatives;
  - Consideration of 1996 routes;
  - Potential regional road corridors;
  - N16/N15 inter connection.
- 'Do-Nothing' and 'Do-Minimum' Alternatives;
- 'Do-Something' Alternatives, including:
  - Public Transport Alternative;
  - Traffic Management Alternative;
  - Upgrade in accordance with the Design Manual for Roads and Bridges (DMRB);

Following an assessment of the foregoing, it was established that the viable alternatives would be a design upgrade in accordance with the Design Manual for Roads and Bridges (DMRB).

1.7 The 'Feasible Route Options'

1.7.1 Description of Feasible Route Options

At the initial Feasible Route Options (FRO) Stage, 13 various options went forward for assessment. The design of Route Options is an iterative one and commenced with the development of 'Feasible Route Options'. There were 11 initial FRO's, with 2 additional extension's to Options 01A and 02A, giving a total of 13. These options are described figuratively in Volume 5 (Fig. N16-RS-003), of the Route Selection Report and grammatically in section 7.3. The routes can be separated into four strategic options as outlined below:

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A;
  - Red – Feasible Route Option 01A/01B;
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A
  - Yellow - Feasible Route Option 02A/2B
- *Rathbraghan* to the County Boundary:

- Green - Feasible Route Option 03
- Light Blue - Feasible Route Option 04
- Lime Green - Feasible Route Option 10
- Grey – Feasible Route Option 11

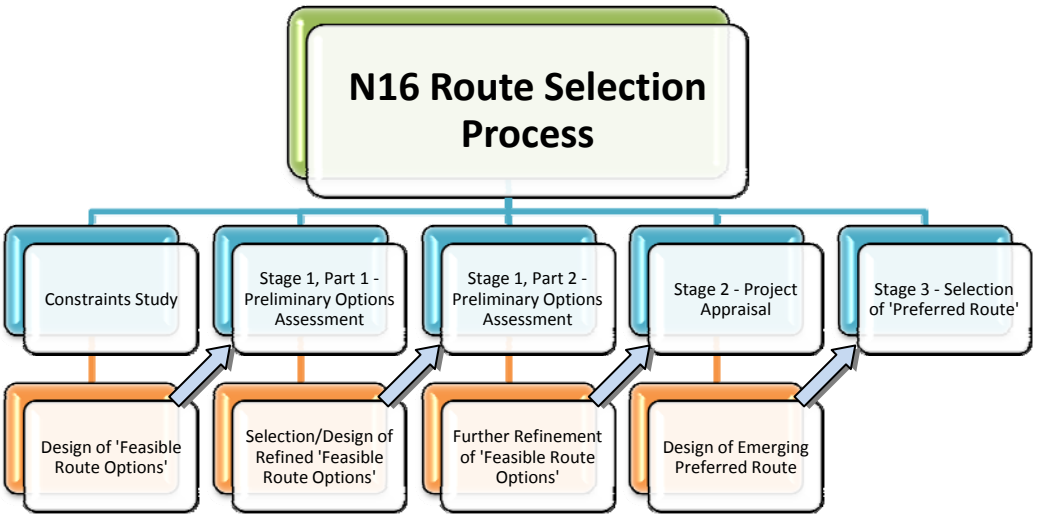
➢ AbbVie Roundabout to the County Boundary:

- Blue - Feasible Route Option 05;
- Pink - Feasible Route Option 06;
- Brown - Feasible Route Option 07;
- Black - Feasible Route Option 08;
- Purple - Feasible Route Option 09;

1.8 Assessment process and Selection of the 'Preferred Route'

The selection of the preferred route for the N16 has been an iterative one, supported by a number of key stages which are summarised in Figure 1-4 below.

Figure 1-4: Stages of N16 Route Selection



The Constraints Study Phase and the initial 'Feasible Route Options' have already been alluded to in this Executive Summary. The following briefly describes the subsequent stages which followed.

1.8.1 **Stage 1, Preliminary Options Assessment**

1.8.1.1 Stage 1, Part 1 - Preliminary Options Assessment

The Feasible Route Options, referred to in section 1.7.1, were subjected to the Stage 1 – Part 1: Preliminary Options Assessment which is expanded upon in section 9 of this Main Report.

The assessment was undertaken by a multi disciplinary range of specialists under the following headings:

Engineering

- Road Engineering;
- Road Safety Impact Assessment;
- Traffic;

Economics

- Options Comparison Estimate;

Environment

- Landscape & Visual;
- Flora, Fauna & Fisheries;
- Agricultural Property;
- Non-Agricultural Property (Domestic, Industrial, Commercial etc.);
- Noise & Vibration;
- Air Quality & Climate Change;
- Hydrology & Hydrogeology;
- Soils & Geology;
- Archaeology & Cultural Heritage;
- Architectural Heritage;
- Socio Economic;
- Urban Planning.

An expansion of the assessment is provided in Volumes 2, 3, and 4 which accompany this Main Report. In addition, Volume 5 (Figures) provides information in relation to route options design, the overall study area and impact assessment.

A 'Framework Matrix' ranking template and an associated 'Scorecard' was developed by the project team and applied by each individual specialist to the various assessments being undertaken. Each route was relatively ranked in order of preference from 1 to 13. These ranks were then applied to the 5 separate 'Preferences' as outlined in Table 1-1.

Table 1-1: Application of Ranks to 'Preferences'

Preference	Preference Rank
Very High Preference	1
High Preference	2
Medium Preference	3
Low Preference	4
Very Low Preference	5

In consideration of the fact, that the establishment of a 'Preferred Route' is best done on an iterative basis, whereby, the establishment of an optimal route location becomes clearer as the process evolves and more detailed information becomes available, it was considered appropriate to establish 'Sectional Splits' which would allow for the breaking up of 'Feasible Route Options' and the subsequent amalgamation of preferential sections.

These 'Sectional Splints' are outlined in Figure N16-RS-002 (Volume 5) and in summary, include 3 sections described for the purposes of the Route Selection Report as the:

- Southern Section;
- Central Section; and
- Northern Section.

The first stage of the refinement process included an examination of the following:

(1) The 'Preliminary Options Assessment' reports;
(2) The completed scorecards;
(3) Discussions at a Multi Disciplinary Workshop;

The Preliminary Options Assessment reports informed the scorecard described at (2), which in turn facilitated a number of reviews from differing perspectives including 'Full Scores Compilation' and 'Averaging as per Framework Matrix Criteria'. The outputs from points (2) and (3), facilitated interactive discussions between the Multi Disciplinary Team during the workshop described in section 9.6.1.4 of the Route Selection Report

The following sections outline the recommendations which arose from the initial assessment process.

1.8.1.1.1 *South Section - Recommendations*

Discount Options

In relation to the South Section, it was recommended that options 03, 04, 10, 11, 06, 07 and 09 be discounted for reasons which are set out in section 9.6.1.5.4 of this Route Selection Report.

Design Modifications

It was considered following assessment that some option's, could be modified in a manner which could possibly make them more desirable solutions. In this regard, further modified alternatives were considered for Feasible Route Option, 01A, 01A/02B, 02A, 02A/02B and 08. This involved the establishment of 2 supplementary amalgamated options which were subsequently labelled as option 12 and 13. Further information in relation to these design modifications is set out in section 9.6.1.5.4 of this Route Selection Report.

1.8.1.1.2 *Central Section - Recommendations*

Discount Options

In relation to the Central Section it was recommended that options 01A, 02A, 03, 04, and 10 be discounted for reasons which are set out in section 9.6.1.6.4 of this Route Selection Report.

Design Modifications

In a similar manner to the South Section, some options were considered further in terms of design modifications, to establish if they would become more desirable solutions. In addition to a modified version of option 08, an amalgamated option 12 was also established. Further information in relation to these design modifications is set out in section 9.6.1.6.4 of this Route Selection Report.

1.8.1.1.3 *North Section – Recommendations*

Discount Options

In relation to the North Section it was recommended that options 01A, 02A, 03, 04, 05, 10 and 11 be discounted for reasons which are set out in section 9.6.1.7.4 of this Route Selection Report.

Design Modifications

Similar to other sections, some options were considered further in terms of design modifications to establish if they would become more desirable solutions. In addition to a modified version of option

08, an amalgamated option 12 (with two variations) was also established. Further information in relation to these design modifications is set out in section 9.6.1.7.4 of this Route Selection Report.

1.8.1.1.4 *Selection/Design of Refined 'Feasible Route Options'*

The outcome of the 'Preliminary Options Assessment' (Part 1) resulted in a refinement of the route options, which included discounting of certain options and applying design changes to others which also included the breaking down and amalgamation of certain sections.

These options are described figuratively in Volume 5 (Fig. N16-RS-004) and grammatically in section 10.1 of the Route Selection Report. The routes can be separated into three strategic options as follows:

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A – v2;
  - Red – Feasible Route Option 01A/01B – v2;
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A – v2;
  - Yellow - Feasible Route Option 02A/02B – v2;
- AbbVie Roundabout to the County Boundary:
  - Blue – Feasible Route Option 05;
  - Black - Feasible Route Option 08 – v2;
  - Brown - Feasible Route Option 12 (and option 12-v2);

1.8.1.2 Stage 1, Part 2 - Preliminary Options Assessment

The Refined 'Feasible Route Options' described above were subjected to a second stage of 'Preliminary Options Assessment' defined within this report as 'Part 2' and described within this Main Report in section 10 (and figuratively in Volume 5).

The assessment process was carried out to a similar level of detail which has already been outlined for the Stage 1, Part 1 - Preliminary Options Assessment; that is with the exception of the Traffic and Transport Assessment which expanded in detail to consider fifteen Key Performance Indicators at a Strategic and Specific level.

The recommendations on the options refinement is set out in section 10.6 of this Route Selection Report, this process resulted in the discounting of options 01A/01B-v2, 02A-v2 and 02A/02B-v2 in the South Section (See Section 10.6.1.1.4 for further details).

1.8.1.2.1 *Further Refinement of 'Feasible Route Options'*

The Stage 1, Part 2 assessment resulted in a further refinement of route options down to 3.

The routes can be separated into two Strategic Options as outlined below:

- N15 (connection at *Teesan Td.*) to the N16 County Boundary:
  - Red – Feasible Route Option 01A – v2;
- AbbVie Roundabout to the County Boundary:
  - Blue – Feasible Route Option 05;
  - Brown - Feasible Route Option 12 (and option 12-v2);

1.8.2 Stage 2 - Project Appraisal

The three Refined Feasible Route Options were subjected to the Stage 2 (Project Appraisal Matrix) which is described in Section 11 of the Route Selection Report. The objectives of the scheme are appraised in accordance with national transport planning policy, using the common appraisal framework based on the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

These criteria were used to measure and compare the ability of each particular route option to deliver the defined objectives which are expanded upon in section 4 of this Route Selection Report.

The Multi Criteria Analysis performance matrix for Stage 2, Project Appraisal is outlined in Table 1-2. This matrix which is inverted, from that which was used in the initial Stage 1, Preliminary Options Assessment (i.e. positive scores are high indexes as opposed to low ones) is a similar integer system to that recommended in *PE-PAG-0203, Project Appraisal Guidelines for National Roads Unit 7.0 - Multi Criteria Analysis.*

Table 1-2: TII PAG – MCA Criteria

Score Index	Impact Level
7	Major, or Highly Positive
6	Moderately Positive
5	Minor, or Slightly Positive
4	Not significant, or neutral
3	Minor, or slightly negative
2	Moderately negative
1	Major or highly negative.

The assessment and its results are outlined in Volume 6 of the Route Selection Report.

Prior to the completion of the Multi Criteria Analysis, additional studies were undertaken in relation to:

- Traffic and Transport Assessment;
- Economic Analysis; and
- Road Safety Assessments.

The results of the Multi Criteria Analysis are outlined in the Table 1-3 and Table 1-4. The following outlines the main factors considered to influence the comparison of route options, with particular regard to the satisfaction of objectives as set out in section 4 of this Route Selection Report.

Economy

The Economic criteria, was appraised under the headings of: *Efficiency and Effectiveness*, W*ider Economic Impacts*, *Transport Quality & Reliability* and *Funding Impacts*.

The measure of *Wider Economic Benefits* and *Funding Impacts* was considered to be similar for each of the route options.

In terms of *Efficiency and Effectiveness*, Option 05 was considered the best option achieving a Net Present Value of Benefits amounting to €25.618m and a Benefit to Cost Ratio of 0.992, in the Design Year of 2047. Option 12 achieved a Net Present Value of Benefits amounting to €20.471m and a Benefit to Cost Ratio (BCR) of 0.848 in the Design Year of 2047. It is expected that both these options should achieve a BCR greater than '1', once Safety is factored and in this regard, both were considered to achieve the scheme objectives.

Option 01A-v2 did not satisfy the desired objective as it will not achieve a Net Present Value of Benefits which will outweigh the Net Present Value of Costs.

In terms of *Transport Quality & Reliability*, each of the route options will increase average journey speeds on the rural section to over 90kph, thereby achieving the Level of Service D in the design year, which is a required objective of the proposal. In a comparison of journey times between the Leitrim County Boundary and Sligo City Centre, Option 05 achieved the best saving of 01 minute and 09 seconds, compared with 52 seconds for option 12 and 23 seconds for option 01A-v2.

Safety

The Safety criteria, was appraised under the headings of *Collision Reduction* and *Security*. In terms of *Collision Reduction* a similar monetary saving is considered at this stage of the assessment to occur for each of the route options; however, considering the qualitative results of the Road Safety Impact Assessment and the Road Safety Audit (Stage F), Option 05 was considered overall to be a marginally better route, the primary reason for this is that it retains the existing N16 traffic and is 600m shorter than option 12.

In terms of *Security*, each of the options were considered to exhibit similar characteristics insofar as, the proposed new route will either include a dedicated cycle/pedestrian track, or will facilitate the use of the existing N16 as a suitable track. Direct domestic and agricultural tracks, will as far as practicable be removed from the national primary route and accommodated via the provision of new improved junction arrangements. In addition, results of the traffic model analysis, indicates that the provision of the scheme will not impact on future plans to pedestrianise sections of Sligo City which are objectives of the Sligo & Environs Development Plan.

Considering the foregoing, each of the route options were considered to achieve the objectives set out in section 4 of the Route Selection Report.

Environment

There were thirteen different disciplines considered in the Environmental Criteria. Overall, the Multi Criteria Analysis is slightly below the 'Minor, or Slightly Negative' Index for Options 01A-v2 and 05, and slightly above the 'Minor, or Slightly Negative' Index for option 12. This indicates that Option 12 is marginally the best option from an overall Environmental perspective. The variance of indexing is generally as a result of Option 12 impacting to a lesser degree, on aspects relating to Urban Planning, Socio Economic, Agricultural and Non-Agricultural Property.

As each option could generally be considered to have an overall MCA Index of 'Minor, or Slightly Negative', it is considered that this maintains environmental impacts to as an acceptable level as is possible. In this regard each option is considered to achieve the Environmental objectives.

The design phase of the Emerging Preferred Route will in certain cases, improve the existing environmental condition where that is possible. This will include for example: improved water quantity and quality treatment measures, improved amenity benefits for those properties in the vicinity of the existing N16 and improved amenity benefits for vulnerable road users.

Accessibility & Social Inclusion

Accessibility & Social Inclusion is measured in terms of *Deprived Geographical Areas* and *Vulnerable Groups*. In both instances it was considered that all route options were similar overall and they each achieved the objectives to improve road based public transport and facilities for those without a car.

Integration

The Integration criteria, was appraised under the headings of: *Transport Integration, Land use Integration, Geographical Integration* and *Other Government Policy Integration*.

Each of the three route options were considered to achieve these objectives with similar results. In terms of *Transport Integration* each route option provides for a good strategic connection while they each also, via the provision of adjacent cycling/walking facilities, improve the connectivity of existing sustainable transport networks, particularly between Sligo and Glencar. In terms of *Land Use Integration* each option complies with the objective of the County Sligo Development Plan to realign and upgrade the existing N16, while also improving a Strategic Radial Corridor within the Border Regional Planning Guidelines (2010-2022). Each option also satisfies the objective in terms of *Geographical Integration*, as they each improve the N16 which is part of the comprehensive network of routes supporting the Trans-European Transport Network. They each also satisfy the objectives in terms of *Other Government Policy Integration* as they improve a 'strategic linking corridor' as defined in the National Spatial Strategy.

Physical Activity

The Physical Activity criterion considers the nature of physical activity impacts including impacts on particular groups of road users such as pedestrians and cyclists.

An examination of Physical Activity related benefits was undertaken by the design team; however, due to the current low level of pedestrian/cyclist usage on the N16 and the difficulty establishing future usage which might arise from the new facilities, it was not considered appropriate to quantifiably factor this criterion into the Multi Criteria Analysis.

However, there will be benefits arising (although currently immeasurable). These will include:

- Health benefits to pedestrians and cyclists, who take up or increase their levels of physical exercise, as a result of the improved new provisions as a result of the road infrastructure;
- A reduction in work related absenteeism as a result of increased physical activity;
- An improvement in journey ambience benefits as a result of the users' perception of reduced danger (a reduced fear of potential collisions/incidents) and improved quality of journey as a result of the proposal being considered. Existing users will experience these improvements as well as any new users who are attracted to the facility;
- The upgraded facility for cyclists and pedestrians is expected to have a lower cyclist and pedestrian incident risk associated with it than in the existing situation. For existing cyclists and pedestrians there is therefore likely to be a collision/incident reduction benefit

- Journey time may also be improved for some cyclists/pedestrians as a result of shorter journey times.

Table 1-3: Multi Criteria Analysis Results

N16 Sligo to County Boundary - MCA - Summary			
Sub Criteria	**Option 1A-v2**	**Option 05**	**Option 12**
	Index	**Index**	**Index**
Urban Planning	3.5	3.5	4
Socio Economic	4	4.8	4.7
Noise & Vibration	4	4.2	4.2
Air Quality	4.2	4	4
Agriculture	1.7	1.3	2.2
Non - Agri	1.7	2.3	2.7
Flora, Fauna & Fisheries	2.7	2.2	2.3
Hydro and Hydro Geology	2.25	2.25	2.5
Soils & Geology	3.3	2.7	3.3
Waste	3	3	3
Landscape & Visual	1.8	1.8	1.8
Archaeology & CH	1.5	2	1.7
Architectural H	2.3	2	2.3
Evironmental average Index	**2.77**	**2.77**	**2.98**
Sub Criteria	**Index**	**Index**	**Index**
Collision Reduction	6	6.5	6
Security	7	7	7
Safety average Index	**6.50**	**6.75**	**6.50**
Sub Criteria	**Index**	**Index**	**Index**
Efficiency and Effectiveness	2	4	3.5
Wider Economic Impacts	4	4	4
Transport Quality and Reliability	5	6	5.5
Funding Impacts	4	4	4
Economy average Index	**3.75**	**4.50**	**4.25**
Sub Criteria	**Index**	**Index**	**Index**
Deprived Geographical Areas	5	5	5
Vulnerable Groups	4	4	4
Accesibilty/Social Incl. agerage Index	**4.50**	**4.50**	**4.50**
Sub Criteria	**Index**	**Index**	**Index**
Transport Integration	6	6	6
Land use Integration	7	7	7
Geographical Integration	7	7	7
Other Government Policy Integration	7	7	7
Integration agerage Index	**6.75**	**6.75**	**6.75**

Table 1-4: Multi Criteria Analysis Results

Multi Criteria Analysis Summary			
Sub Criteria	**Option 1A-v2**	**Option 05**	**Option 12**
	Index	**Index**	**Index**
Evironmental average Index	2.77	2.77	2.98
Safety average Index	6.50	6.75	6.50
Economy average Index	3.75	4.50	4.25
Accesibilty/Social Incl. agerage Index	4.50	4.50	4.50
Integration agerage Index	6.75	6.75	6.75
Average	**4.85**	**5.05**	**5.00**

1.8.3 **Recommendation**

1.8.3.1 Summary of Refined Route Options

Option 01A-v2

Option 01A-v2 which broadly corresponds with the 1996 Route Option, was considered to compare well against other options under the overall *'Environmental'* criteria, it was however, considered to be slightly less desirable than Option 12. In terms of *'Safety'*, it was considered slightly less desirable than Option 05, but similar overall to Option 12. The option was also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

However, the route did not compare well against Option 05 or 12, in relation to *Economy* overall, and more specifically in relation to *Efficiency & Effectiveness* and *Transport Quality & Reliability*. The route option did not achieve a Benefit to Cost Ratio which was close to, or greater than '1'; therefore it was concluded that it did not achieve the scheme objectives of an efficient network, this can largely be attributed to the fact that the route does not retain all Sligo bound traffic, south of its junction with the L-3406-0 (Drum Road).

Option 05

Option 05, was considered to compare well against other options under the overall *'Environmental'* criteria, it was however considered to be slightly less desirable than Option 12. In terms of *'Safety'*, Option 05 was considered to be slightly more desirable than Options 01A-v2, or Option 12. The option was also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

Option 05 is the most preferred option in relation to *Economy* overall. When safety is factored in, the route will achieve an overall Benefit to Cost Ratio which is greater than '1', thereby achieving the scheme objectives of providing an efficient network adding to the overall welfare of society.

Option 12

Option 12 in an overall *'Environmental'* perspective could be considered to be slightly more preferable than options 01A-v2, or option 05. In terms of *'Safety'*, it was considered slightly less desirable than Option 05, but similar overall to Option 01A-v2. The option was also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

In terms of Economy, and more specifically *Efficiency & Effectiveness* and *Transport Quality & Reliability* the route was slightly less desirable than option 05, however it should still achieve the scheme objectives once Safety is factored in.

1.8.3.2 Recommendation for Further Assessment

Considering the foregoing, options 05 and 12 were considered overall to meet the scheme objectives and were both considered to be potentially viable routes. As option 01-v2 does not achieve the overall scheme objectives it was not considered further.

Prior to concluding on the selection of an Emerging Preferred Route, a direct Pair Wise comparison was undertaken on both these viable options. However, in advance of same, it was considered appropriate, arising from the environmental assessment set out in this Route Selection Report, to merge option 05 in the south with option 12 (north of *Castlegal* townland), this corresponds with the iterative nature of the process and allows to further reduce the potential for environmental impacts. In addition it ensures any bias is removed from a direct comparison of both options. This new route is labelled for the purposes of this assessment as option $05^{(S)}/12^{(N)}$.

1.8.4 Pair Wise Comparison

The following sets out the results of the Pair Wise comparison between option $05^{(S)}/12^{(N)}$ and option 12.

1.8.4.1 Economy

Efficiency and Effectiveness[5]

In terms of Efficiency and Effectiveness, under a 30 year appraisal period option $05^{(S)}/12^{(N)}$ achieves circa €5.15m benefits over option 12. The BCR for option $05^{(S)}/12^{(N)}$ is 0.992 (exclusive of safety) compared against 0.848 for option 12.

In order to as far as possible, correlate these differences into the Multi Criteria Analysis it was considered appropriate to undertake a pro-rata adjustment.

A score of '4' which corresponds to 'Not Significant, or Neutral' (exclusive of Safety) was considered appropriate for option $05^{(S)}/12^{(N)}$, considering the BCR established is almost '1'. The BCR of option 12 (0.848) is approximately 15% less than 0.992 therefore the Index of '4' was factored down to 3.42, this corresponds to 'Minor, or Slightly Negative, to Not Significant or Neutral'.

These scores are considered to be representative of the difference between the 2 options.

Wider Economic Impacts

Both options are considered similar in terms of Wider Economic Impacts. Each option is considered to be 'Not Significant, or Neutral' (Index of 4).

Transport Quality and Reliability

In terms of Transport Quality and Reliability; journey times (of N16 traffic between the County Boundary and the City Centre) were averaged over the AM, Interpeak and PM periods to reveal that

[5] Although option $05^{(S)}/12^{(N)}$ will not require the underbridge structure associated with the L-3404-0; on a conservative basis it was decided not to factor down the Options Comparison Estimate for this option. This was in consideration of the fact that a farm underpass may be determined to be required for option $05^{(S)}/12^{(N)}$ at design stage – in this regard, this was considered to balance against the aforementioned underbridge.

$05^{(S)}/12^{(N)}$ achieved a saving of 72 seconds, compared with 53 seconds for option 12. Option $05^{(S)}/12^{(N)}$ in this regard is considered to be approximately 17 seconds quicker than option 12 in order to reach this destination.

In terms of MCA Indexing, similar to the Efficiency & Effectiveness criteria, a similar pro-rata exercise was carried out. The base score was considered to be option $05^{(S)}/12^{(N)}$ with an index of '6' corresponding to 'Moderately Positive'. On a conservative basis, it was considered that the minimum Index achievable is 'Not Significant, or Neutral' (Index of '4'); therefore on a prorata basis it was calculated that the Index for option 12 is 5.47 (26%[6] less than an Index of '6') corresponding to 'Minor, or Slightly Positive, to Moderately Positive'.

These scores are considered to be representative of the difference between the 2 options.

Funding Impacts

Both options are considered similar in terms of Funding Impacts. Each option is considered to be 'Not Significant, or Neutral' (Index of 4).

1.8.4.2 Safety

Collision Reduction

In terms of Collision Reduction, although both options will provide significant benefits over the existing network, it is considered that option $05^{(S)}/12^{(N)}$ is slightly more desirable given that it is some 600m (circa 7%) shorter than option 12. This means effectively that traffic will spend less time on the network in the case of option $05^{(S)}/12^{(N)}$.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '6.5' corresponding to 'Moderately Positive, to Major, or Significantly Positive' while option 12 received a score '6' corresponding to 'Moderately Positive'.

These scores are considered to be representative of the difference between the 2 options.

Security

Both options are considered similar in terms of Security. Each option is considered to be 'Major, or Highly Positive' (Index of 4).

1.8.4.3 Environment

In terms of the Environment, disparities between the 2 route options occur generally in the area south of *Lugatober;* therefore the Pair Wise comparison is focussed on this particular section. Table 1-5 outlines numerically the comparison of the 2 options, while the proceeding sub sections provides commentary in relation to the various environmental criteria.

[6] Measured between an Index of '4' and '6'.

Table 1-5: Pair Wise Comparison, Environment, South [7]

N16 Sligo to County Boundary - MCA - Summary				
Environment - South				
Criteria	Sub Criteria	Section	Option 12	Option 05/12
			Index	Index
Urban Planning	N/A	South	4.0	3.5
Socio Economic	N/A	South	4.0	4.5
Noise & Vibration	N/A	South	4.5	4.5
Air Quality	N/A	South	4.0	4.0
Agriculture	N/A	South	1.5	1.0
Non - Agri	N/A	South	3.0	3.0
Flora, Fauna & Fisheries	Flora & Fauna	South	3.0	3.0
	Fisheries		2.0	2.0
Hydro and Hydro Geology	N/A	South	3.0	2.5
Soils & Geology	N/A	South	3.0	2.0
Waste	N/A	South	3.0	3.0
Landscape & Visual	Landscape	South	2.0	2.5
	Visual		2.0	2.0
Archaeology & CH	N/A	South	2.0	1.5
Architectural H	N/A	South	2.0	1.5
Evironmental average Index			**2.9**	**2.7**

Urban Planning

In terms of Urban Planning; option 12 does not impact on the planned development areas in the Sligo and Environs Development Plan, while option 05 traverses/subdivides a small portion of planned urban areas.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '3.5' corresponding to 'Minor, or Slightly Negative, to Neutral, or Not Significant', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.

These scores are considered to be representative of the difference between the 2 options.

Socio Economic

In terms of Socio Economics; the main difference between the two options occurs in the area south of the L-7422-0/L-3407-22. Option 12 severs the existing N16 to the north, requiring the occupants of 18 properties to detour up to one kilometre north to a connection with the L-3407-22, while option $05^{(S)}/12^{(N)}$ introduces new severance for *Barroe* properties and maintains some existing severance at Doonally Bridge, although the introduction of a staggered junction between the L3407-0 and L3407-22 reduces this relative to the existing or do-nothing situation. Although, it may be possible to provide an additional access to the proposed route in the case of option 12, which would reduce the severance for the *Barroe* properties, it is considered that this would adversely impact the

[7] This table relates to the **Southern section only** and is provided in order to assist in understanding where the differences occur between the route options. **Table 1-6** provides index scores in relation to the full route sections.

Safety and Collision Reduction Index score; in this regard such a design amendment has not been considered at this stage.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '4.5' corresponding to 'Neutral, or Not Significant, to Minor, or Slightly Positive', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.

These scores are considered to be representative of the difference between the 2 options.

Noise & Vibration

Both options are considered similar in terms of Noise & Vibration.

Air Quality

Both options are considered similar in terms of Air Quality.

Agriculture

In terms of Agricultural Property; In the case of option $05^{(S)}/12^{(N)}$, there will be a High impact on a farm holding on the L-3406-0 resulting from a direct impact on a farmyard comprising of animal housing and other facilities. There is a High impact on a Key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance and the proximity of the alignment to the farmyard. There is also a High impact on one farm holding in *Barroe* arising from landtake and severance.

In terms of option 12, there will be a High impact on five farm holdings in *Barroe, Faughts* and *Doonally* (Calry ED) due to landtake and severance. There will be a Medium impact on a key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1' corresponding to 'Major, or Highly Negative', while option 12 received a score of '1.5' corresponding to 'Moderately Negative, to Major, or Highly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Non – Agricultural Property

In terms of Non-Agricultural Property, there are only slight differences between the 2 options in the section south of *Lugatober*. In the case of option $05^{(S)}/12^{(N)}$ the more notable impacts are a Medium impact on a property in *Barroe* due to the impact on the property curtilage and existing access. There will be a Medium impact on a second property in *Barroe* due to the impact on the property curtilage and existing access.

In the case of option 12, there will be a Medium impact on a property (currently a Day Care Centre) in *Faughts* due to the impact on the property curtilage, existing property access and garden. There will be a Medium impact on a second property in *Doonally* due to the impact on existing access. There will be a Low impact on the remaining properties.

In terms of MCA Indexing, both options received an Index of '3' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the similarity between the 2 options.

Flora, Fauna & Fisheries

Both options are considered similar in terms of Flora, Fauna & Fisheries.

Hydrology and Hydro Geology

Both route options are generally similar in terms of their impact on the Hydrological & Hydrogeological environment. A slight difference occurs in the case of option $05^{(S)}/12^{(N)}$ over option 12, as it may potentially result in the proposed road running almost parallel and in close proximity to the Willsborough stream channel and within the Floodplain for c. 200m, this is balanced against the fact that option 12 traverses an extensive area of pluvial flood risk.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.5' corresponding to 'Minor, or Slight Negative to Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Soils & Geology

Both route options are generally similar in terms of their impact on the Soils & Geology environment; that is with the exception of a more sizeable deficit of fill required for option $05^{(S)}/12^{(N)}$ over option 12.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2' corresponding to 'Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Waste

Both options are considered similar in terms of Waste activities.

Landscape & Visual

Both route options are generally similar in terms of their impact on the Landscape & Visual environment; that is generally with the exception of a long cut section in the south of option 12.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.25' corresponding to just above 'Moderately Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

Archaeology & Cultural Heritage

In terms of Archaeology & Cultural Heritage; Option $05^{(S)}/12^{(N)}$ will result in Significant Negative Impacts on CHC47 (Mill Race) and Moderate Impacts on CHC62 & CHC63 which are both demesne landscapes. Option 12 will result in Moderate Negative Impacts on CHC16 (Ringfort), CHC28 (Ringfort), CHC34 (Enclosure), CHC62 (Demesne landscape), CHC63 (Demesne landscape) and CHC64 (Demesne landscape).

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

Architectural Heritage

In terms of Architectural Heritage; Option $05^{(S)}/12^{(N)}$ will result in a significant impact on AHC 14 (Demesne landscape), AHC 15 (Demesne landscape) and AHC 35 (Bridge). There will be a Moderate

impact on AHC 19 (Mill Race). Option 12 will result in Moderate negative impacts on AHC 6 (Former Doonally School), AHC 15 (Demesne landscape) and AHC 16 (Demesne landscape).

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

1.8.4.4 Accessibility & Social Inclusion

Deprived Geographical Areas

Both options are considered similar in terms of Deprived Geographical Areas (Minor, or Slightly Positive).

Vulnerable Groups

Both options are considered similar in terms of Vulnerable Groups (Not Significant, or Neutral).

1.8.4.5 Integration

Transport Integration

Both options are considered similar in terms of Transport Integration (Moderately Positive).

Land Use Integration

Both options are considered similar in terms of Land Use Integration (Major, or Highly Positive).

Geographical Integration

Both options are considered similar in terms of Geographical Integration (Major, or Highly Positive).

Other Government Policy Integration

Both options are considered similar in terms of Government Policy Integration (Major, or Highly Positive).

1.8.4.6 Physical Activity

Both options are considered similar in terms of Physical Activity.

Table 1-6: Multi Criteria Analysis Results – Following Pair Wise Comparison

N16 Sligo to County Boundary - MCA - Summary		
Sub Criteria	**Option 12**	**Option 05/12**
	Index	**Index**
Urban Planning	4	3.5
Socio Economic	4.7	4.8
Noise & Vibration	4.2	4.2
Air Quality	4	4
Agriculture	2.2	1.8
Non - Agri	2.7	2.7
Flora, Fauna & Fisheries	2.3	2.3
Hydro and Hydro Geology	2.5	2.25
Soils & Geology	3.3	2.7
Waste	3	3
Landscape & Visual	1.8	1.9
Archaeology & CH	1.7	2
Architectural H	2.3	2
Evironmental average Index	**2.98**	**2.86**
Sub Criteria	**Index**	**Index**
Collision Reduction	6	6.5
Security	7	7
Safety average Index	**6.50**	**6.75**
Sub Criteria	**Index**	**Index**
Efficiency and Effectiveness	3.42	4
Wider Economic Impacts	4	4
Transport Quality and Reliability	5.47	6
Funding Impacts	4	4
Economy average Index	**4.22**	**4.50**
Sub Criteria	**Index**	**Index**
Deprived Geographical Areas	5	5
Vulnerable Groups	4	4
Accesibilty/Social Incl. agerage Index	**4.50**	**4.50**
Sub Criteria	**Index**	**Index**
Transport Integration	6	6
Land use Integration	7	7
Geographical Integration	7	7
Other Government Policy Integration	7	7
Integration agerage Index	**6.75**	**6.75**

1.8.5 Conclusion

The results of the MCA are outlined in Table 1-7. The 'Pair Wise' comparison outlined above has directly compared the viable route options which are considered to be option $05^{(S)}/12^{(N)}$ and option 12. In terms of the overall Multi Criteria Analysis assessment, Option $05^{(S)}/12^{(N)}$, achieved an overall index of 5.07 while option 12 received an overall index of 4.99. The main reasons for the more positive score for option $05^{(S)}/12^{(N)}$ relate to the fact that it is a shorter route by approximately 600m which has consequential benefits in term of Economy (Efficiency & Effectiveness, and Transport Quality & Reliability) and Safety.

In terms of environmental effects, both route options are considered to be generally similar in relation to Noise & Vibration, Air Quality, Non Agricultural Property, Flora, Fauna & Fisheries and Landscape & Visual. Option $05^{(S)}/12^{(N)}$ does carry slightly greater environmental impacts over Option 12 in relation to Urban Planning, Agriculture, Hydrology & Hydrogeology, Archaeology & Cultural Heritage and Architectural Heritage; however it is slightly more desirable than option 12 in terms of Socio Economics. It is also notable in relation to option $05^{(S)}/12^{(N)}$ that the most notable agricultural impacts occur on a circa 60 Ha Dairy Farm in *Doonally* townland. In addition, these same lands are classified as a Demesne Landscape in the Architectural Heritage Assessment. In the case of the impact on the aforementioned Dairy Farm, a monetary impact has been applied to the 'Options Comparison Estimate' of Option 05 which reflects the landtake, severance/injurious affection, disturbance and potential accommodation works – in this regard the impact is to a degree factored into the Transport *'Efficiency and Effectiveness'* assessment of the route. The Demesne as observed in a walkover of the lands (28/02/2017) by the Architectural & Cultural Heritage specialist has been modified for the purposes of agricultural use and possesses only small portions of intact landscape perimeter wall.

In this regard; it is proposed, considering the foregoing, that the route as depicted in Volume 5 (Option $05^{(S)}/12^{(N)}$) as Figures N16-RS-052 to 056, be progressed as the Emerging Preferred Route (EPR) for the N16. This EPR shall be encompassed by an 'Route Corridor' which is indicative only and does not represent project extents; this corridor will be used by the Planning Authority for the referral of planning applications to the TII and the National Roads Project Office. However, it is envisaged, insofar as is practicable, that any changes to the 'Emerging Preferred Route' during the design phase, will not extend outside of this 'Route Corridor'.

In addition, considering environmental sensitivities in *Gortnagrelly*, the 'Route Corridor' shall be extended to also cover option 12-v2; this will allow some scope at Environmental Assessment stage to reduce the environmental impacts in this area.

Table 1-7: Multi Criteria Analysis Results

Multi Criteria Analysis Summary		
Sub Criteria	**Option 12**	**Option 05/12**
	Index	**Index**
Evironmental average Index	2.98	2.86
Safety average Index	6.50	6.75
Economy average Index	4.22	4.50
Accesibilty/Social Incl. agerage Index	4.50	4.50
Integration agerage Index	6.75	6.75
Total	*24.95*	*25.36*
Average	**4.99**	**5.07**

1.9 Next Steps

The selection of the Emerging Preferred Route now permits the planning and design of minor improvement schemes (3 to 4 no.) to commence.

iii. BACKGROUND AND NEED

2 Introduction

2.1 General

The Executive Summary, in section 1, sets out the context of this Route Selection Report. The structure of the Route Selection Report is as set out in the 'Preface'. In general this 'Main Report' (Volume 1), sets out the overall course of the Route Selection process, encapsulating where required, aspects of individual reports which are provided in Volumes 2, 3, 4 and 6 – these Volumes should be referred to, in order to gain a greater appreciation of the various studies. Supporting Figures to the Route Selection Report are provided in Volume 5.

The Route Selection Process has been iterative in nature supported by a number of key stages which have already been set out in Figure 1-4 within the Executive Summary.

2.2 Overview of the existing route and problems encountered

2.2.1 Existing Route

The N16 National Primary Route forms part of an East/West corridor linking Northern Ireland with the Republic and more specifically linking Belfast and Dundalk on the east coast with Sligo on the west coast. Emanating from Belfast, the M1 motorway heads west passed Lisburn, Craigavon and Lurgan and terminates at Dungannon reducing to the trunk route (A4) to Enniskillen and the border (see Figure 2-1). In the Republic, it becomes the N16 from Blacklion in Co. Cavan and travels via Manorhamilton in Co. Leitrim to Sligo (See Figure 2-2).

At 49 kilometres (30 miles), the N16 is one of the shorter national primary routes, as it forms only part of a major route from Sligo to Enniskillen and onwards to Belfast. Compared with many other national primary roads in Ireland, long sections of the N16 are narrow and twisty which can make travelling on it slow and difficult. In recent years, improvements have been made to short sections in County Leitrim but no works have been carried out in County Sligo, apart from maintenance and Low Cost Accident Schemes.

The Co. Sligo section is particularly scenic, providing impressive views of the Dartry Mountains and Glencar Lake below and also Sligo Bay, Benbulben, the Atlantic Ocean and south Donegal. The existing N16 route within County Sligo extends from the Ash Lane/N4/N15 junction near Hughes Bridge to the County Leitrim boundary at *Meenaphuill* Townland and has an overall length of approximately 10.4km.

In terms of the Trans European Road Network, the EU have designated the Belfast/Sligo road as part of a:

> *...comprehensive network of routes, feeding into the core network at regional and national level. The aim is to ensure that progressively, throughout the entire EU, the TEN-T will contribute to enhancing internal market, strengthening territorial, economic and social cohesion and reducing greenhouse gas emissions.*

This emphasises the routes strategic importance in linking the peripheral north-west of Ireland with Belfast and the north-eastern ports.

The N16 also forms an essential component in cross-border co-operation.

Figure 2-1: N16/A4 Sligo to Belfast[8]

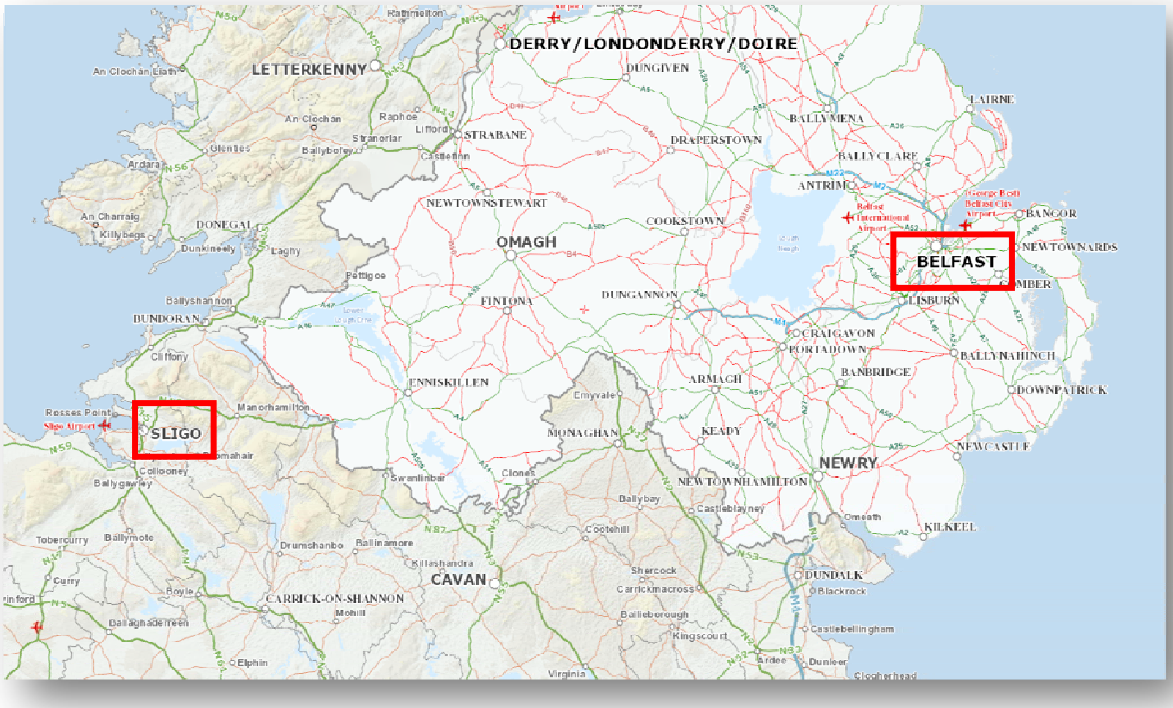
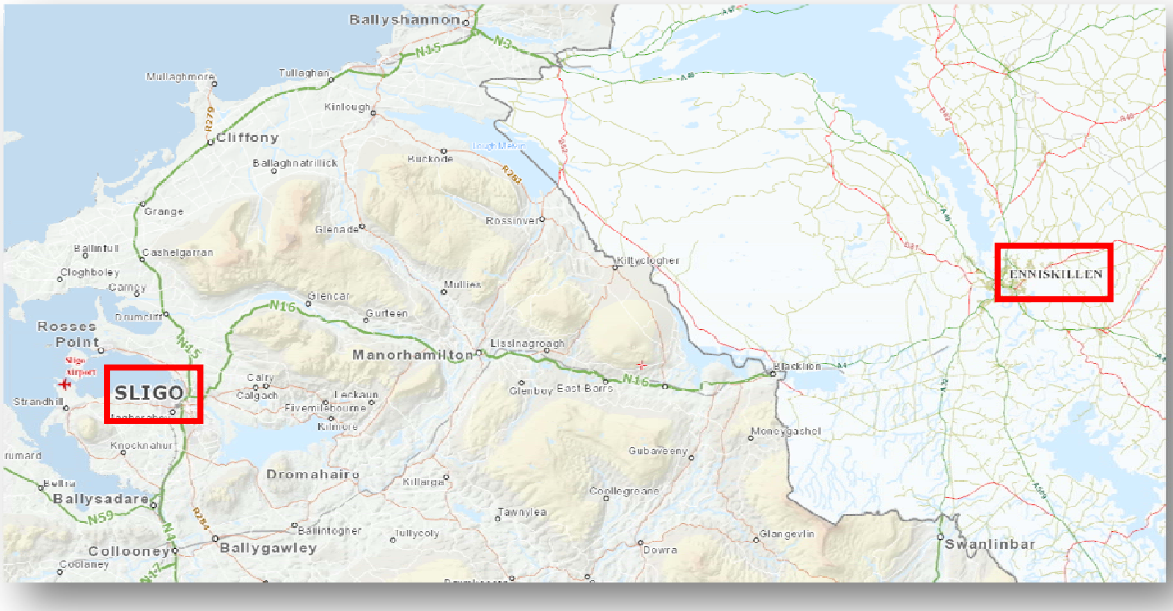


Figure 2-2: N16 Sligo to Enniskillen



[8] www.osi.ie/publicviewer

2.3 Existing Conditions on the National Route

The existing road network in the area is multi-functional and is required to cater for conflicting demands, including accommodating long distance through traffic and locally generated trips.

The route, as it occurs within County Sligo, can be divided into two relatively contrasting sections. The 1.9km section from the N15 near Hughes bridge along Ash Lane past Sligo Institute of Technology as far as the AbbVie Roundabout, is subject to a 50kph speed limit and can be classified as urban in nature. The remaining section (8.5km) of the route is rural in nature and is subject to a 100kph speed limit, it contains sporadic roadside housing development, particularly in the section closer to City.

On the rural section of the route there are approximately eleven clusters of houses (2 or more property entrances) with direct access to the national primary route. The most significant of these clusters occur at *Barroe*, *Doonally* and *Lugatober* townlands. In addition, the route is populated with additional direct house and agricultural entrances.

The entire rural section has a substandard cross section coupled with a grossly inadequate vertical and horizontal alignment (as per section 3.5.2.2.3). This is predominately due to the topography of the area which could be described as hilly to mountainous. Consequently, from *Doonally* townland northwards the road follows a winding, somewhat tortuous route, around the slope of Copes mountain from an elevation of less than circa (c.) 50m O.D. at *Doonally* to c. 130m O.D. at the Leitrim Boundary.

The urban section between the junction with the N4/N15 and the AbbVie Roundabout is generally of good standard.

There are a significant number of junctions (23) with local roads along the existing route. Safety issues in relation to these junctions are expanded upon in section 3.5.2.2 of this report.

3 Need for the Scheme & Problem Definition

3.1 Need for the Scheme

At a policy and strategic level, there is a clear need for an upgrade to the existing N16, which is repeated in numerous International, National and Regional Development Policies. These are expanded upon in section 3.2 and include *inter-alia*:

- TEN-T Trans European Transport Network;
- National Spatial Strategy for Ireland 2002-2020: People, Places and Potential[9];
- Regional Planning Guidelines for the Border region, 2010-2022;
- Border, Midlands and Western Regional Operational Programme, EU Regional Policy, 2007-2013;
- Smarter Travel, a Sustainable Transport Future, 2009-2020;
- Implementing the NSS: Gateway Investment Priorities Study, 2006; and
- Forfás Regional Competiveness Agenda, 2010;
- Sligo County Development Plan;

Numerous studies commissioned by various organisations including *inter-alia:* Transport Infrastructure Ireland (formerly NRA), Irish Central Border Area Network (ICBAN), North West Region Cross Border Group (NWRCBG) and the various regional Local Authorities have identified the significant deficiencies and the 'Needs' for upgrading of the N16. These reports (which are expanded upon in section 3.2.8), in conjunction with scheme specific assessments outlined in this Route Selection Report establish the following recurring themes:

- Average journey times on this route are significantly lower than journey times on other national primary routes (this has significant effects on journey times from Sligo to Belfast);
- There is an under investment in transport infrastructure in the Regional area;
- The geometry is significantly deficient for a national primary route;
- A strategic core East-West Route is best served by a corridor through Sligo-Enniskillen-Dundalk;
- Infrastructural investment on both sides of the border has been dictated by the policies set out in the respective national strategies, and is driven primarily by a desire to link the major population centres within the respective jurisdictions as a first phase, extending to linking population centres across the Island as a second stage. Furthermore, the two strategies have not historically been integrated on a cross-border basis. This has had a significant effect on any planned upgrades to the N16 in the past;
- There is, according to a number of studies, a close correlation between the standard of a region's transport infrastructure and its development status; internationally, a poor transport infrastructure has been shown to have a major inhibiting impact on investment and both economic and social development, including in the areas of the quality of life, access to both fundamental and specialist amenities, international access and access to major local and national social events;

[9] To be succeeded by the National Planning Framework

- The Gateways and Hubs identified in the National Spatial Strategy, other than Dublin, have benefitted substantially in terms of improved employment accessibility. However, Sligo is a notable exception due in part to the lack of significant upgrades to its national road networks.

3.2 Summary of Road Development Policy

3.2.1 TEN-T Trans European Transport Network

The TEN-T Trans European Transport Network which was the subject of Regulation (EU) No. 1315/2013, provides for the TEN-T Trans European Network and requires the development of a core network by 2030 with a connecting comprehensive network of high quality routes incrementally by 2050. The requirements for the comprehensive network, is described by the regulations as follows:

> *'The comprehensive network should be a Europe-wide transport network ensuring the accessibility and connectivity of all regions in the Union, including the remote, insular and outermost regions, as also pursued by the Integrated Maritime Policy established by Regulation (EU) No 1255/2011 of the European Parliament and of the Council, and strengthening social and economic cohesion between them. The guidelines laid down by this Regulation ("the guidelines") should set the requirements for the infrastructure of the comprehensive network, in order to promote the development of a high-quality network throughout the Union by 2050.'*[10]

Figure 3-1: TEN-T Trans European Transport Network

[10] REGULATION (EU) No 1315/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, of 11 December 2013, on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU

3.2.2 National Spatial Strategy for Ireland 2002-2020: People, Places and Potential[11]

The National Spatial Strategy (NSS), published in November 2002, is a 20 year broad planning framework for the entire country, identifying development patterns for different areas, and setting indicative policies for the location of different types of development in the future. The NSS guides future infrastructural, industrial, residential and rural development while providing protection for Ireland's cultural, natural and environmental heritage, promoting social inclusion and enhancing quality of life.

The NSS has identified transportation and roads as key elements within the infrastructure of the country. The NSS recognises that highly developed infrastructures are features of strong economic performance and balanced regional development. Quality road networks are therefore crucial to economic development. The NSS supported the implementation of the road investment programme which was outlined within the NDP by recognising that it is a key element in improving regional accessibility and regional development.

In relation to strengthening the West and North West in a National Strategic Context the NSS states:

> *Additional gateways, particularly in the West and North West, where the urban structure is weakest, must be developed. In identifying new gateways, a number of key factors must be taken into account including strategic location, capacity for substantial development, an existing business and innovation dynamic and existing or potential transport linkages.*
> *Critical mass in the West and North West can be strengthened by developing Sligo as a gateway to capitalise on its strategic location and energise its associated hinterland. Building up the national role and scale of Sligo will require, as a first step, the development of a planning, land use and transportation framework. This will provide a focus around which local authorities, business and community interests can reach consensus on the future development of Sligo and utilise its substantial physical capacity for development, while safeguarding its outstanding natural setting.*[12]

Under 3.7, Key Infrastructure, the NSS states:

> *Achieving spatial balance by developing the potential of areas will depend on enhancing capacity for the movement of people, goods, energy and information between different places. Improvements in terms of time and cost, can reduce the disadvantages of distance.*
> *Physical networks of infrastructure such as roads, public transport, energy and communications are of particular relevance to the NSS, since they themselves have a spatial impact and also influence the location, timing and extent of development.*[12]

Under 3.7.1, Transport, the NSS states:

> *To support balanced regional development, Ireland's transport networks must...*
> - *...ensure, through building up the capacity and effectiveness of Ireland's public transport networks, that increases in energy demand and emissions of CO2 arising from the demand for movement are minimised;*
> - *allow internal transport networks to enhance international access to all parts of the country, by facilitating effective interchange possibilities between the national transport network and international airports and sea ports;*

[11] To be succeeded by the National Planning Framework

[12] National Spatial Strategy for Ireland 2002 – 2020: People, Places and Potential

- *address congestion in major urban areas by increasing the use of public transport.*

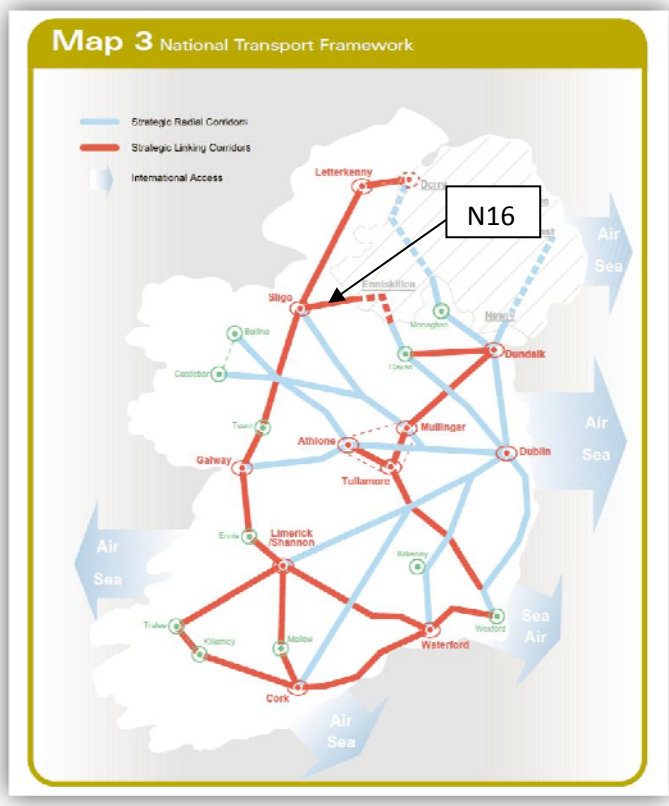
Decisions on land use and development must take account of the existing public transport networks or support the emergence and development of new or augmented networks.

In summary, Ireland's future transport network can be viewed in terms of

- ***strategic** radial **corridors***
- ***strategic** linking **corridors***
- ***strategic** international **access points.***[12]

The N16 is identified as a strategic linking corridor, providing north western international access and access from Sligo through the Central Spine of the Country to the East.

Figure 3-2: National Transport Framework, (Map 3 of National Spatial Strategy)



The National Spatial Strategy also recognises the benefits that cooperation across political boundaries can help to realise economic potential in the border areas. In this regard it states the following:

...With changing circumstances, advantage can also be derived from viewing the central part of the border area as a 'crossroads' between Dublin, Belfast, Derry, the Midlands and other strategic locations such as Sligo...

3.2.3 Regional Planning Guidelines for the Border region, 2010-2022

The Regional Planning Guidelines were prepared by the former Border Regional Authority (which was dissolved on 1st June, 2014). The new Northern and Western Regional Assembly now encompasses County Sligo.

Notwithstanding the foregoing, in order to demonstrate the policy context of the route the Guidelines recognised that creating competitive capacity and critical mass requires supporting economic development and improving economic infrastructure across the region.

The Regional Planning Guidelines (RPGs) is a long term strategic planning document which aims to direct the future growth of the Border Region, and seeks to implement the planning framework set out in the National Spatial Strategy. The N16 from Sligo to the County Boundary is listed as one of the major schemes in planning which will have a significant influence on the Border Region in the coming years.

The Regional Planning Guidelines identified the N16 as a Strategic Link in a West/North Central Corridor which:

> *Links the Gateway of Sligo and the Gateway of Enniskillen in Northern Ireland and forms part of the Northern Cross (See Section 3.7.4.3* **[Quoted below]**[13]*). The Sligo to Enniskillen route also provides access to the international access point of Belfast/Larne and links to the Key Transport Corridor of Enniskillen/ Dungannon/ Craigavon/ Belfast, as identified in the RDS. Improvements to this route in recent years have been limited to short isolated sections. The route requires substantial investment as a matter of priority.*[14]

Additionally it states that a priority for this route is the development of the:-

- N16 Sligo to Enniskillen (including Manorhamilton Bypass and the southern Bypass at Enniskillen (outside the Border Region))

In terms of the Central Border Region and the Northern Cross described above (See Figure 3-3); the Guidelines state the following:

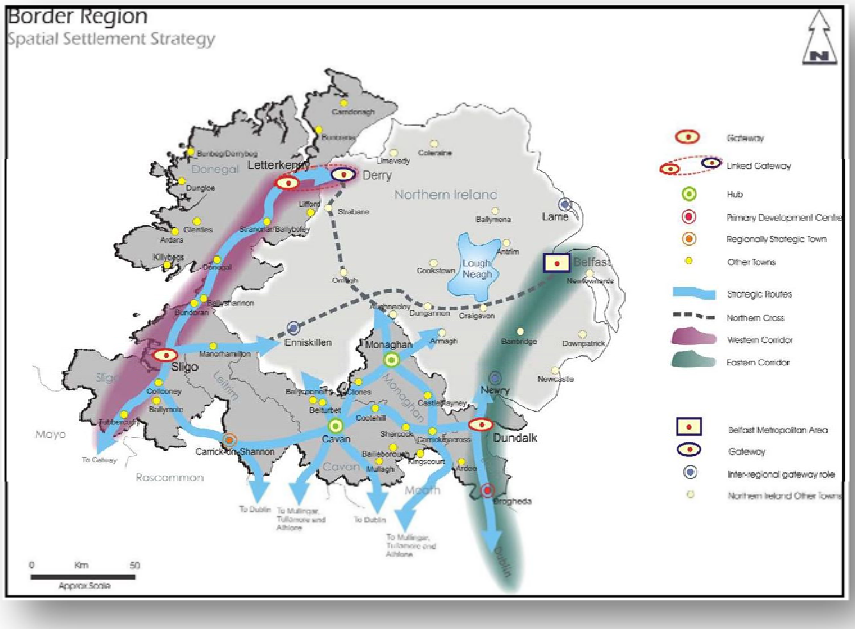
> *The Central Border Region is an integral area which will benefit greatly from the implementation of the balanced settlement model. The aim of the model is to reposition the spatial perception of the central and western portions of the Border Region from that of a peripheral area, to that of an area which is pivotal to the future development of the island and regeneration of its economy. At a practical level, the Central Border Region will emerge as a spatial and economic entity in its own right. Its future functionality has the potential to provide a central connective, economic and infrastructural endoskeleton; linking East with West, and creating wider added value. With strategically supported and co-ordinated development, the Central Border Region has the capacity to increase the impact and benefits across the Border Region, of predicted and evidenced growth in the Eastern Corridor and the Atlantic Arc. It will reciprocally benefit these growth corridors on the basis of connected complementarity. It will no longer function largely at the extremities of wide catchment influences of Dublin and Belfast, but will develop and retain strong connections to both city regions, and provide a further link to other key settlements in the North and North West. Development of the model will also link this Region with adjoining Regions, particularly the Midlands and West Region...*
>
> *...In seeking to ensure the balanced development of the Central Border Region, and in acknowledgement of this Region's role in providing connectivity and added value to neighbouring growth corridors, the* ***Northern Cross****, (see Spatial Settlement Strategy*

[13] Authors insertion

[14] Regional Planning Guidelines for the Border Region, 2010-2022, Border Regional Authority

map), is an important infrastructural element in developing this Region as well as others. The Northern Cross, providing strategic high speed road access from Dublin to Letterkenny/Derry (N2/A5), and from Belfast to Sligo/Enniskillen (M1, A4, ***[N16]***[15]*), has the potential to spatially reintegrate much of the entire historic province of Ulster, including the south and west of Northern Ireland and the counties within the Border Region. Since 2004, these key corridors have gained strong political support in both jurisdictions, with advanced works already on-going on some routes, particularly on the extension of the M1 from Belfast to Ballygawley, and the A4 towards Enniskillen. The further development of the Northern Cross will act as the conduit for the economic re-invention of the Border Region both north and south. Not only is the Northern Cross a key infrastructural concept for the Central Border Region, but it is also one which provides an essential infrastructural link between both jurisdictions on the island.*[14]

Figure 3-3: Spatial Settlement Strategy



3.2.4 Border, Midlands and Western Regional Operational Programme, EU Regional Policy 2007-2013[16]

In relation to National Primary routes the Border, Regional and Western Regional Operational Programme states that:

...by improving access this strategy would also improve access to the region, connectivity within the region and enhance the economic contribution of the designated Gateways and Hubs and maximise the returns to investments made in other infrastructure such as Ports and Airports.

[15] Authors Emphasis

[16] Although this document has now expired, it is deemed appropriate to reference, in relation to N16 project 'Needs' which have historically been established.

3.2.5 Smarter Travel, a Sustainable Transport Future (2009-2020)

Smarter Travel, a Sustainable Transport Future (2009-2020) is a transport policy for Ireland introduced by the Government in 2009 to:

- Enhance our communities;
- Improve our environment;
- Make our economy more efficient and competitive, and;
- Significantly add to the equality of life for all our citizens.

Development of the N16 Sligo to County Boundary would support these objectives insofar as a safer environment will be provided to allow for the promotion of local commuting by walking and cycling.

3.2.6 Implementing the NSS: Gateway Investment Priorities Study, 2006[17]

The Gateway Investment Priorities Study commissioned by the Department of the Environment examined the NSS implementation process in Gateways and prioritised key investment needs for them.

The report identified priorities for Gateways and how these may be incorporated into subsequent National Development Plan's. A focus on key regional roads particularly those linking Gateways with one another and their hinterland was identified as a priority. In the long term the East West link road was identified as important for the border region both in term of improving access in the region and between the Republic and Northern Ireland.

> *East to West road connectivity to improve access throughout the border region and between Northern Ireland and the Republic is a long term priority,* ***[particularly the Dundalk-Sligo route]***[18] *through Cavan.*[19]

3.2.7 Forfás Regional Competiveness Agenda (2010);

Under the heading *Economic Infrastructures: Access and Connectivity*, Forfás Regional Competiveness Agenda (2010) states that:

> *Although access to the Border region has improved greatly over recent years, significant connectivity issues remain to be addressed. Progress has been achieved in terms of road access over recent years, and there is a clear understanding, north and south of the border, of the main transport corridors that need to be developed. Priority road projects include: A1 (Newry-Belfast), N2 (Dublin-Derry), N14 (Lifford-Letterkenny), [N16/A4 (Sligo-Dungannon)]20 and N17 Galway-Sligo...*[21]

[17] Although this document has now expired, it is deemed appropriate to reference, in relation to N16 project 'Needs' which have historically been established.

[18] Authors Emphasis

[19] Implementing the NSS, Gateway Investment Priorities Study, 2006, DoEHLG

[20] Authors Emphasis

[21] Forfás Regional Competiveness Agenda, 2010

3.2.8 Investing in our Transport Future, Strategic Investment Framework for Land Transport;

Investing in our Transport Future is a Strategic Investment Framework for Land Transport, published by the Department of Transport, Tourism and Sport in 2015. The Framework which was based on a wide-ranging policy analysis exercise, aims to establish key principles and priorities to guide transport investment over the coming decades.

Priority 3, which seeks to maximise, through targeted investments, the contribution of land transport networks to our national development, which:

- *enhance the efficiency of the existing network, particularly through increased use of ITS applications;*
- *improve connections to key seaports and airports;*
- *in the case of roads, provide access to poorly served regions, for large-scale employment proposals, to complete missing links and to address critical safety issues; and*
- *support identified national and regional spatial planning priorities.*

Targeted improvements on the N16 would satisfy this priority, particularly under the final 2 investment criteria.

3.2.9 Sligo County Development Plan, 2011 – 2017

It is the objective of Sligo County Council to bring National Roads up to appropriate standards, as resources become available, and to continue improvement works on non-national roads so as to develop a safe and comprehensive road system for the county. As part of this, there is an objective to facilitate programmed improvements to the National Road network including the realignment of the N16 Sligo City to Leitrim County boundary. So the realignment of the N16 is in accordance with the Sligo County Development Plan as it has been specifically identified as a national road to be improved under the plan.

3.3 N16 specific studies

Over the course of the past number of decades, numerous studies have been undertaken which demonstrate the deficiency of the existing N16 in terms of its function as a North-South and East-West Strategic Route. The following provides an overview of some of the more significant findings of some of these studies which demonstrates a 'Need' for the upgrade of this route.

3.3.1 The EU Socio-Economic Case for Improvements to the N16/A4 Sligo to Ballygawley and N2/A5 Monaghan to Letterkenny Transport Corridors, October 2012;

This report sets out the socio-economic case for improvements to transport infrastructure in the Border Area of Northern Ireland (NI) and the Republic of Ireland (RoI). Through undertaking a thorough and objective-led review of options, the document established the economic justification and sequencing for investing in new transport links in the Border Area. MVA Consultancy, in association with Stephen Wood Consultancy, was appointed by the Irish Central Border Area Network (ICBAN), in partnership with the North West Region Cross Border Group (NWRCBG), to undertake this study during 2011/12.

The report was set in the context of the wider 'Central Border Region Spatial Planning Initiative' being developed by ICBAN. The Spatial Planning Initiative was supported by the European Union's INTERREG IVA Programme managed by the Special EU Programmes body to facilitate the move to a new level of strategic planning and coordinated action for regional development in the border areas. The evidence in this socio-economic and business case suggests that the border area performed

poorly in economic terms when compared to the wider island of Ireland and it can be strongly argued that this is at least in part attributable to its low quality transport infrastructure.

Key transport problems in the Border area were identified within the report as being:

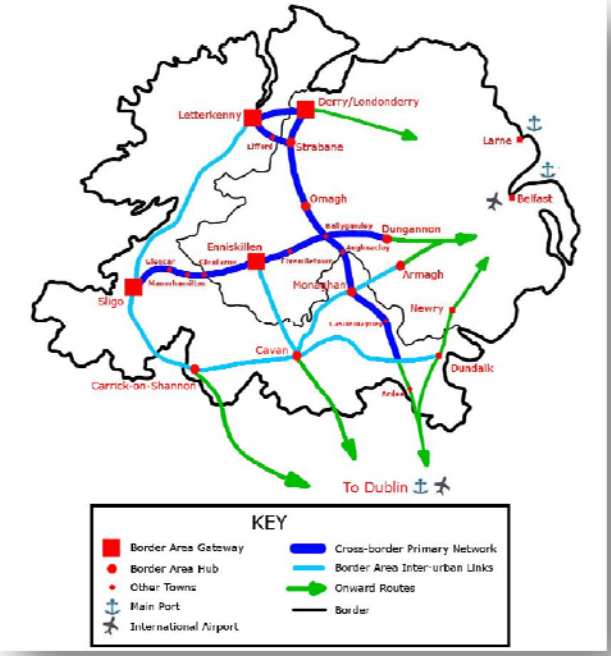
- *Long travel times and hence poor accessibility to key economic centres;*
    - *average speeds from the Border Area towns to Dublin is **71kph**, compared to **85kph** from the other towns; and*
    - *average speeds from the Border Area towns to Belfast is also **71kph**, compared to **76kph** from the other towns.*
- *Under-investment in transport infrastructure in the area – recent NRA spending per head on transport infrastructure in the Border area is around 45% of that of other Irish regions;*
- *Some routes in the area **[(notably the N16)]**[22] are not of the required standard for a designated National Primary Road;*
- *Issues with journey time reliability, particularly for traffic passing through the town of Enniskillen; and*
- *Conflicts between local and strategic traffic.*[23]

Figure 3-4 below summarises the principal recommendations of the study in context. The dark blue lines represent the principal recommended improvements identified in the report. In addition the roads linking the principal Border Area towns should be reviewed and improved in order that the target average inter-urban speed of 80 kph is achievable.

[22] Authors Emphasis

[23] The EU Socio-Economic Case for Improvements to the N16/A4 Sligo to Ballygawley and N2/A5 Monaghan to Letterkenny Transport Corridors, October 2012

Figure 3-4: Principal recommendations of EU Socio-economic case for improvements to the N16/A4 and N2/A5

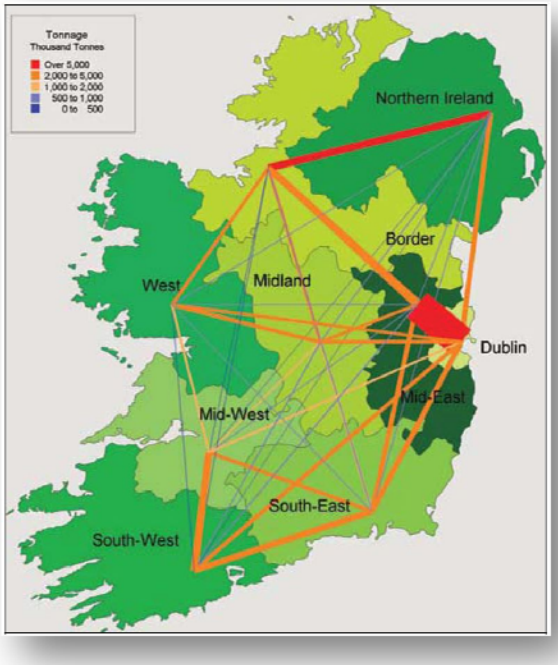


In terms of the volume of freight moved, the report makes the finding (as per Figure 3-5) that :

> *...the Border Region is the most freight intensive area of Ireland outwith the Dublin conurbation*[24]

[24] Inter Trade Ireland, *Freight Transport Report for Ireland* (Newry, 2008), p. 33.

Figure 3-5: Freight tonnes moved by road between NUTS[25] 3 regions



The report goes on to suggest in relation to the Border Region that:

> *...A recurring theme in the analysis has been doubt over the impact of transport improvements in an area with an already well developed transport network, the UK being a frequently cited example...*
> *The work of Bradley and Best on the Border area suggested the creation of an economic development zone and it can be argued that targeted transport investment to support such aspirations could be of considerable value.*
> *Evidence from the seminal Eddington study also suggested that improvements to links to key gateways, ports and airports can deliver the largest economic impacts. A number of the proposed interventions in this study would enhance links between the gateways of Derry /Londonderry, Sligo and Letterkenny with the rest of the island of Ireland and beyond...*[23]

Additionally:

> *The findings very clearly demonstrate that average speeds are higher when travelling from towns such as Galway, Cork, Waterford and Limerick to Dublin or Belfast compared to the Border Area towns, making them more accessible and thus fostering stronger economic linkages with the core economic hubs. This is a key point – **[the Border area is, in effect, 'further away' from the main economic growth poles and thus is less likely to benefit from investments that require good mobility]**[26].*
> *A case in point would be to compare Sligo and Galway, which are both of a similar distance to Dublin. Galway however benefits from the M6 motorway, providing an average speed 19kph higher than Sligo. While both areas are of a broadly similar*

[25] *Nomenclature of Units for Territorial Statistics*

[26] Authors emphasis

distance to Dublin, the M6 makes Galway 'closer', with travel requiring only two hours 18 minutes as opposed to three hours 15 mins from Sligo. [23]

In summary the report concludes that in the long-term, ICBAN should look towards a time-specific commitment to improve both corridors along their entire length. The study has prioritised these improvements for each corridor in relation to the A4/N16:

Priority 1: *Provision of a bypass of Enniskillen;*
Priority 2: *Progressive upgrades to the N16, beginning with the section between Glencar and Glenfarne, including the Manorhamilton Bypass, followed by the* ***[Sligo to Glencar]***[27] *section and finally the Glenfarne to Blacklion section;*
Priority 3: *Provision of a bypass of Fivemiletown; and*
Other: *Improvements to the A4 between Enniskillen and Belcoo - in the interests of a consistent minimum standard of route.* [23]

3.3.2 The Border Region East-West Corridor study;

In 2009 Cavan County Council procured a Roughan 'O' Donovan/Aecom alliance to undertake a review of a previous strategic study conducted in 2001 (Strategic Study of the Development of the East –West Link), in the context of current policy and conditions. A Steering Committee comprising representatives from the Department of Transport, Cavan County Council, Monaghan County Council, Louth County Council, Sligo County Council and Leitrim County Council, together with the project consultants, was established to monitor the progress of this phase of the project.

In terms of a Planning Context the report made the following general observations:

There are a number of common themes in all of the national policy documents, namely:

- *The importance of balanced regional development, in order to avoid congestion in some areas, and provide for development in other more remote areas.*
- *A development strategy which is based on the development of a hierarchy of settlements, including Gateway, Hubs and clusters.*
- *The need for greater cross border co-operation and linkages, which will benefit the border areas, but also key urban areas in both the north and south.*
- *The requirement for a quality strategic road network, which is a key requirement to maintain regional, national and international competitiveness.*

In order to assist in balanced regional development, the strategy is to target investment at regional weakness, in particular infrastructural deficiencies.
The National Development Plan refers to the Sligo-Enniskillen-Dundalk route as a key strategic crossborder route. The National Spatial Strategy indicates a road connection between Sligo and Dundalk, via Carrickmacross, Cavan and Enniskillen. It is termed a National Transport Corridor.
The Regional Development Strategy and the Regional Transport Strategy for Northern Ireland both advocate the development of a south-western corridor from Belfast to Enniskillen. Links between Enniskillen-Sligo, Armagh-Dublin and Ballygawley – Monaghan are also referred to.
The regional policy documents endorse the national strategies, particularly in terms of balanced regional development, cross-border cooperation and investment in infrastructure. The Regional Planning Guidelines specially refers to the development of

[27] Authors emphasis

the "East-West" route on a number of occasions, although does not advocate a particular route. It does refer to Cavan in this context, leading to the possible conclusion that a route through Cavan is a favoured one.
The Cavan and Monaghan County Development Plan advocate different routes. The latter has a policy to provide the route through Castleblayney, Ballybay and Clones, whilst Cavan has objectives to provide a route via Shercock, Cootehill, Cavan and Belturbet. Both Sligo and Leitrim County Councils endorse development of the N4 and the N16.[28]

Arising from the policy review; consideration was given to the provision of a core route as well as other additional links to serve the population within the study area, in order to redress the historical deficit from which the region has suffered. Based on this requirement and taking note of current policies a set of scheme objectives was established for the project. These were agreed by the Steering Committee and are summarised as follows:

3.3.2.1 Economic:

- Reduce the travel time required to access jobs, education and services;
- Reduce the travel times for access to regional, national and international markets;
- Deliver a road network which achieves its required functions in a cost effective manner;
- To avoid potential adverse impacts of new transport infrastructure on the efficiency of existing transport corridors.

3.3.2.2 Environmental:

- Minimise the potential for urban sprawl as a result of the provision of new transport infrastructure;
- Contribute to reductions in air pollution and noise;
- Minimise adverse environmental impacts of new infrastructure.

3.3.2.3 Accessibility:

- Maximise access for the catchment population to education, employment and other services;
- Maximise accessibility between hubs & gateways as defined in the National Spatial Strategy;
- Maximise accessibility to key urban settlements in Northern Ireland;
- Maximise accessibility to air and sea ports to ensure competitiveness in international markets;
- Reduce the impact of incidents on the strategic road network through the provision of route choice for longer distance traffic.

3.3.2.4 Integration:

- Facilitate sustainable Land Use and Transport Planning through the provision of transportation infrastructure;
- Support effective and efficient operation of public transport services;
- Connect regional hubs and gateways to support balanced regional development in gateways as defined in the National Spatial Strategy.

[28] The Border Region East-West Corridor study, Roughan O Donovan/Aecom Allianz, 2009

3.3.2.5 Safety:

- Reduce the quantum of HGV traffic travelling through town centres;
- Reduce the quantum of traffic using poor quality roads.

Figure 3-6: Study Area

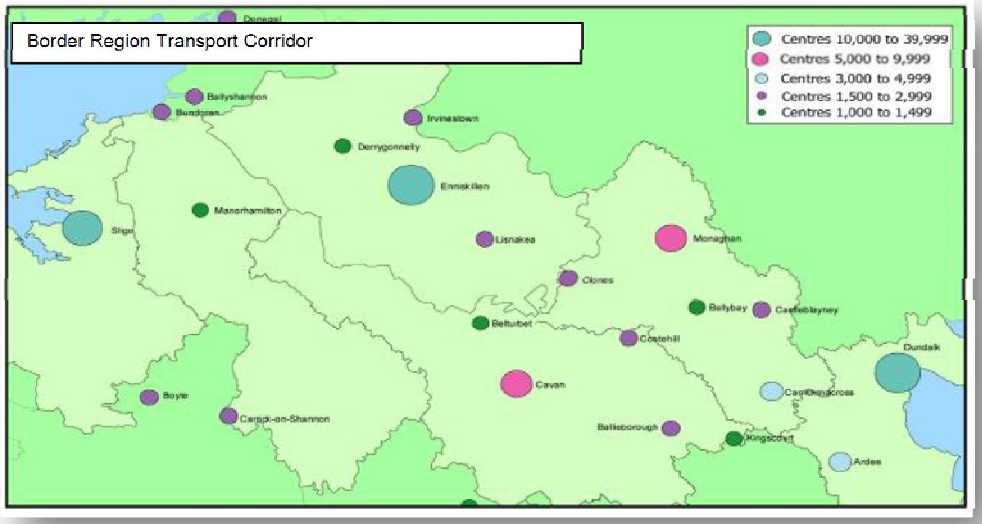
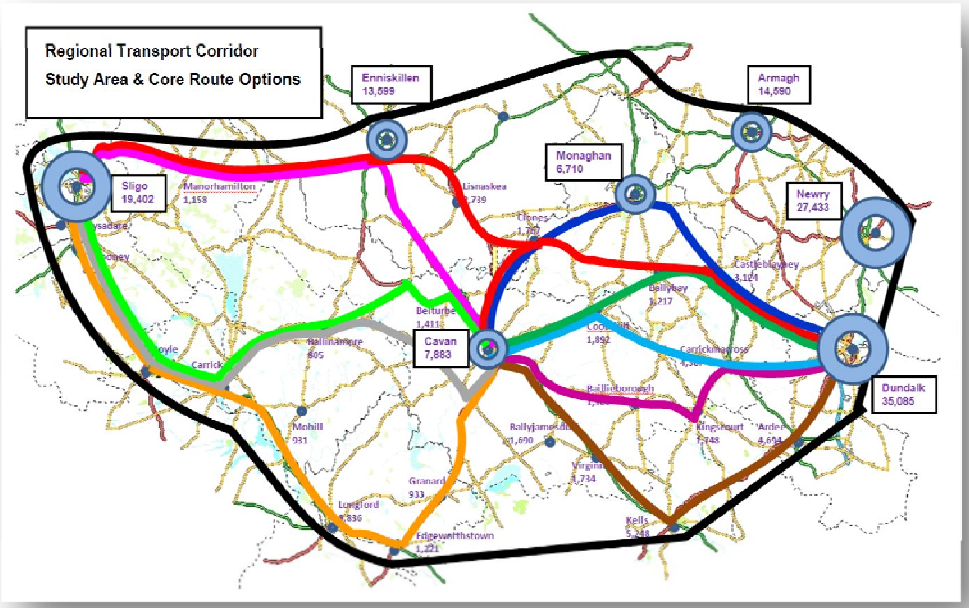


Figure 3-7: East – West potential corridors (Border Region East-West Corridor)



The report undertook an appraisal of each of the route options outlined in Figure 3-7 under the objectives described in 3.3.2.1, 3.3.2.2, 3.3.2.3, 3.3.2.4 and 3.3.2.5. The appraisal recommended that the Strategic Core East West Route linking Sligo to Dundalk should encompass the N16 between Sligo and Enniskillen.

3.3.3 Analysis of Need for up-grading of N16-A4 Arterial Route.

An 'Analysis of Need for up-grading of the N16/A4 Arterial Route' was undertaken by Peter Quinn Consultancy on behalf of Sligo and Fermanagh County Councils in 2008.

The report relates to how some of those same issues and implications, affect the economies and societies of Sligo (and by extension, other parts of North-West Connacht, especially Mayo and North Galway), North Leitrim (with some implications for the rest of that County too), parts of West Cavan, most of Fermanagh and a small part of South Tyrone (in Dungannon and South Tyrone District Council area). It identifies how the opportunities, which exist for more sustainable regional development in these areas, are being inhibited by the inadequacies of the roads system and what needs to be done to change that.

In terms of context setting the report makes some interesting observations including *inter-alia*:

> *...The Government of the Republic has invested heavily in improving the national roads network, as part of its National Development Plan. Within that Plan, there is a very strong commitment to promoting all-Island co-operation, though the main emphasis, in the cross-border transport initiatives to date, has been on improving the routes between Dublin and the two main population centres in the North (Belfast and Derry). The policies in the National Development, in relation to cross-border co-operation, are also reflected in the European Special Peace and Reconciliation Programme, which proposes an all-island approach to reducing economic fragmentation and promoting greater economic interaction; it notes that "Firms tend to shun border regions and infrastructural links are not developed, resulting in unbalanced economic growth"[29]. That view is also reflected in the INTERREG IV Programme...*
>
> *...Effectively, infrastructural investment on both sides of the border has been dictated by the policies set out in the respective national strategies, and is driven primarily by a desire to link the major population centres within the respective jurisdictions as a first phase, extending to linking population centres across the Island as a second stage. Furthermore, the two strategies are not integrated on a cross-border basis (though there have, in recent months, been some moves in that direction* **[2008 statement]**[30]*).* ***[Consequently, the N16 has received little investment]***[31] *and it is still narrow, winding and unsuitable for heavy traffic – though parts of it (especially some stretches in Cavan and parts of Leitrim) have been much improved in recent years. One consequence of its poor standard is that this route has a much higher accident rate, including those leading to fatalities, relative to its traffic levels, than the national average...*
>
> *...While this route does not carry very high levels of traffic on the stretch between Sligo and Enniskillen (the figures for the Enniskillen-Ballygawley section are much higher), it is immensely important to the manufacturing sector in the West of Ireland; most products from those areas, including those arising from food processing, engineering, pharmaceuticals/medical devices and other manufactured items, are exported via the port of Larne...*[32]

[29] PEACE III – Operational Programme (page 109)

[30] Authors Insertion

[31] Authors Emphasis

[32] Analysis of Need for up-grading of N16-A4 Arterial Route, Peter Quinn Consultancy, 2008

In an encompassing review of the County Development Plans, Local Area Plans and Regional Plans (for the Regions/Counties in proximity of the N16/A4) the report outlined the obvious awareness to upgrade the route, as the primary road link between the North-East and the West of Ireland. The report states that the main arguments for such an upgrade include the following:

(i) there is an excessive dependence on road transport (for both goods and people) on both sides of the border; in respect of goods, it represents over 99% of the total movements involved, and over 96% for passenger movements;

(ii) businesses in this region (particularly those involved in the transportation sector and those, whose businesses involve the transportation of heavy goods) perceive the inadequacy of the roads infrastructure as the single most important problem they encounter; it was ranked as the single most pressing issue at a recent meeting of Chief Executives of businesses in Fermanagh;

(iii) the absence of joined-up roads planning, both within each jurisdiction and on a cross-border basis, and of accessible and convenient public transport facilities, combine to increase the cost of doing business in these areas, by a significant percentage, and reduces the competitiveness of businesses located in such areas – thereby inhibiting the achievement of 'balanced regional development' on a polycentric basis[33], as enshrined in the European Spatial Development Perspective and the Lisbon Strategy, both of which have been accepted in principle by the two governments and by the European Parliament;

(iv) basing infrastructural investment decisions on current traffic counts perpetuates a bias against more remote areas, because they take no account of the traffic and business which could be attracted, if the roads system was better;

(v) there is, according to a number of studies, a close correlation between the standard of a region's transport infrastructure and its development status; internationally, a poor transport infrastructure has been shown to have a major inhibiting impact on investment and both economic and social development, including in the areas of the quality of life, access to both fundamental and specialist amenities (quoting health care as an example), international access and access to major local and national social events.

Essentially, virtually all the previous studies emphasised the impact of an inadequate roads infrastructure on the economy of such areas, but there was also an underlying theme of its contributing to social disadvantage and general deprivation, with disparities in regional development being explained largely in those terms.[32]

3.3.4 Transport Research & Information Note; Impact of Improvements in the Road Network on the Accessibility & Economic Potential of Counties, Urban Areas, Gateways & Hubs

In 2012, Aecom undertook a study on behalf of the National Roads Authority which looked at the contribution that the road network makes to improving accessibility and developing the economic potential of counties, gateways and hubs throughout the island of Ireland. The report examines the concept of effective density and sets out the relationship between this measure of agglomeration

[33] In European terms, 'polycentric' tends to relate to transnational links (primarily between national capitals), but the concept has equal validity, on a regional basis, in the context of an Island like Ireland.

and productivity; it utilises results from the National Transport Model (NTM) to measure the accessibility of a given location to other geographic areas and so provide an insight into economic potential.

A general summary of the findings of the report indicate that

> *...firms in dense urban areas have higher productivity and lower costs than those in more rural settings, other things being equal. The scale of a firm's "locality" is in part determined by accessibility...*
> *... If transport system improvements bring geographic areas closer together through accessibility enhancements, then the "effective density" of that area is raised. Thus, economic productivity gains can be realised through transport system improvements that raise effective density...*
> *...Studies in the UK and New Zealand support the view that increasing the effective density of a given area increases the productivity of firms with the area. The evidence is that a doubling of effective density leading to a 4 to 7% increase in productivity of firms overall, with very much higher impacts in the service sector...*[34]

More specifically in relation to Sligo Gateway City, significant findings include the following statement:

> *The Gateways and Hubs identified in the National Spatial Strategy, other than Dublin, have benefitted substantially in terms of improved employment accessibility. However,* ***[Sligo is a notable exception:]***[35] *the lack of a significant upgrade to the N4 in the period under review prevented an improvement in employment accessibility.* [34]

In addition to the N4 which is quoted in the study; the lack of upgrades to the N16 would be considered to be equally important as this route is a strategic North/South and East/West corridor.

3.3.5 Other Historical Studies

There have been many other historical studies carried out over the course of the last three decades by various authorities. The findings of these are generally expected to have been considered in the context of the various reports described above, some of these studies include:

- Strategic Study of the development of an east west link Road, Cavan County Council, 2001;
- Improvement of Strategic Corridor, National Primary Route N16, Sligo to Blacklion; Joint Submission from Cavan, Leitrim and Sligo County Councils, March 1996; and
- ICBAN/NWRCBG, Transportation Infrastructure Strategy, Indecon, 1998.

3.4 Planning Context; Sligo County Council

3.4.1 N16 Preliminary Report, 1996.

A comprehensive study comprising a preliminary assessment, addressing the possibilities of improving or replacing the N16 National Primary Route within County Sligo was carried out in 1995/96 by Sligo County Council.

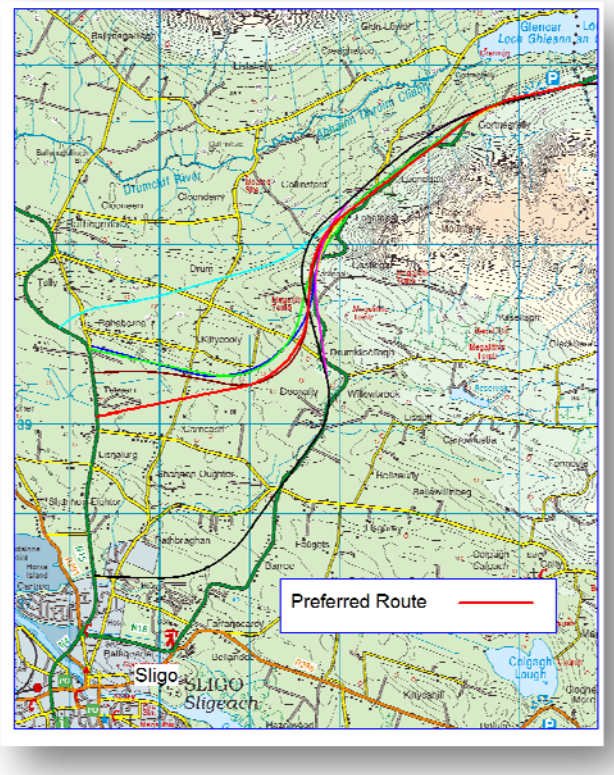
[34] Transport Research & Information Note; Impact of Improvements in the Road Network on the Accessibility & Economic Potential of Counties, Urban Areas, Gateways & Hubs, Aecom/NRA, 2014

[35] Authors Emphasis

The report provided an assessment at that time, of the viable options for an upgrade of the N16. The report established that a route entering County Sligo at or near the existing entry point in *Meenaphuill* townland was the most suitable and this was confirmed by an independent assessment carried out by Leitrim County Council. The objective of the report was to identify a preferred route corridor which would provide a high quality safe access to Sligo City. The report which was presented to Sligo County Council in November 1996 identified such a route and received approval from the NRA to proceed to a part 'X' in March 1999 (Figure 3-8) (This in effect never materialised).

This route was subsequently adopted as part of the Sligo and Environs development plans for 1999-2004, 2005-2011 and 2010-2016. This 'Route Selection Report' as already outlined in section 1.1 now supersedes the 1996 report, from a current day perspective.

Figure 3-8: Preliminary Options Assessment 1995/1996



3.4.2 Sligo and Environs Plan 2010 - 2016

The current Sligo and Environs Development Plan has adopted the initially selected route from the study described in 3.4.1 as outlined in Figure 3-9. A stated objective of the Development Plan is the:

> ***Continued upgrading of road links to Northern Ireland***
> *This measure relates to the N16, which is the major link from Sligo to Enniskillen and Belfast.*[36]

Figure 3-9: N16 Preferred Route

3.5 Problem Definition

3.5.1 Traffic Volumes and Trip Attractions

3.5.1.1 Traffic Volumes

The Traffic Model as developed by Jacobs Engineering, provides an overview of the traffic volume's within the study area. Table 3-1 outlines 2015 traffic statistics at various points along the existing route.

Table 3-1: Indicative N16 Traffic Figures

Location	AADT (2015)	% HGV 2015
N16 - City Centre at Ash Lane	10,500	6%
N16 - City Centre, between the Junction with the R286 and the AbbVie Roundabout	4,600	10%
N16 - Between the AbbVie Roundabout and the junction with the L3406-0 (Drum Road)	3,800	10%
N16 - Between the L3406-0 (Drum Road) and the County Boundary	3,400	11%

3.5.1.2 Trip Attractions

As part of the Irish Census (2011), the Central Statistics Office (CSO) produced the Place of Work, School, or College Census of Anonymised Records (POWSCAR) database. The POWSCAR dataset provides detailed data on the journey to work/education at Electoral Division (ED) level. This data includes:

[36] Sligo and Environs Development Plan; 2010 - 2016

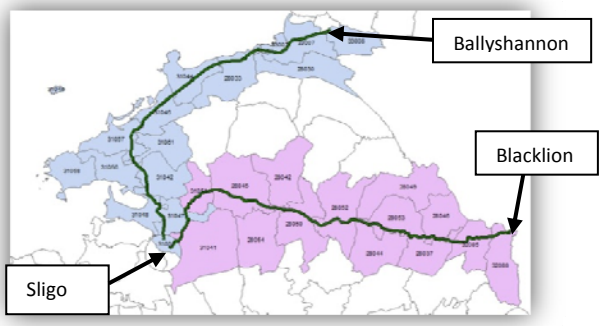
- Origin (residence) and Destination (place of work/education);
- Time of departure; and
- Travel mode.

Outputs from the POWSCAR dataset provided the data required to construct journey to work (commuting) and journey to education Origin-Destination (O-D) demand matrices for use in the TII National Transport Model (NTM). This is the first time that journey to education has been recorded as part of the census. In the previous census (2006) only data on journeys to work was collected.

This information proved to be useful at Feasibility Stage, in terms of establishing the interaction between the N16, Sligo City (and other routes to the south), and the N15 to the north. In this regard, information was extracted from the NTM for the N16 between Sligo and the boundary with Northern Ireland, and for the N15 between Sligo and Ballyshannon (See Figure 3-10). The results demonstrated that:

- Circa (c.) 88% of traffic on both the N15 and N16 are Sligo City bound trips;
- c. 4% of Traffic on the N16 is attracted to the Rosses Point Area;
- The balance (circa 8%) is attracted to the N15, with c. 6% of these trips attracted to the area south of Drumcliff;
- The N15 traffic which are attracted to the N16, are primarily attracted to the section of the N16 closest to Sligo.

Figure 3-10: ED Map N15 (Sligo to Ballyshannon)/ N16 (Sligo to Northern Ireland boundary)



3.5.2 Scheme Specific Assessment

In terms of Problem Definition, the following sets out some of the deficiencies which have been established on the N16.

3.5.2.1 Journey Time Assessment

Journey Time assessments were undertaken by the design team as part of Phase 1 of the Project Development. The initial results indicated that Journey Times appear to be generally reasonable within the urban area, with the exception of some queue delays on the approach to the N16's junction with the N4/N15. However, on the 8.5km rural section, travel times at an average of 70.5kph are significantly below the standards[37] which would be required on a current day national primary route.

[37] Which is a Level of Service D approximately equating to an average inter-urban speed of 80 km/h

3.5.2.2 Safety

The following sections outline the safety deficiencies along the route with particular emphasis on Cross Section, Drainage, Geometry and Junctions. Section 3.5.2.2.6 outlines the accident statistics determined from the Road Safety Authority records.

3.5.2.2.1 *Cross Section*

The cross section of the existing road is described below in terms of notably differing sections.

Section 1: N4/N15 Junction to the N16's junction with the R286

Section 1, consists of 2 number 4.6m wide carriageways with a ghost island and right turning facilities introduced for the entrances to Sligo General Hospital and the Institute of Technology, Sligo. A footway is provided on the right hand side (as one travels to Enniskillen); with a footway, cycleway and green buffer zone provided on the left hand side.

In general the section is urban in nature with boundary walls being the normal definition of the roadside.

Figure 3-11: Section 1; Typical Cross Section

Section 2: N16's junction with the R286 to its junction with the AbbVie Roundabout

Section 2, consists of 2 number 4.3m wide carriageways with a ghost island of varying width provided throughout. A footpath is provided on either side with cycle tracks alternating from one side to the other. The ghost island ends prior to the approach to the AbbVie Roundabout. In general, the section is urban in nature with boundary walls being the normal definition of the roadside.

Figure 3-12: Section 2; Typical Cross Section

Section 3: AbbVie Roundabout to the County Boundary

The rural section (Section 3) of the route generally consists of a single carriageway in each direction with approximate overall widths of 6m to 6.5m. The verge width varies throughout but is generally 1m with localised areas of up to 2.5m.

Figure 3-13: Section 3; Typical Cross Section

3.5.2.2.2 *Drainage*

With the exception of the urban section, where drainage in the form of kerb and gully is provided, the remaining rural section of the N16 is generally devoid of a dedicated drainage system. Along the route, verge cuts provide the only means of escape for road runoff, meaning flash floods and aqua-plaining is a common feature following heavy rainfall events. This is exacerbated by the topography of the area, where in some cases the road intercepts sheet flow (following heavy storm events) from the adjacent Copes Mountain.

Figure 3-14: Flooding/Aqua-plaining

3.5.2.2.3 *Geometry*

The geometry of the existing route has been examined, based upon a Topographical centreline survey of the existing road and a subsequent analysis carried out in the Road Design computer package MXRoads.

The TII DMRB specifies a hierarchy of thresholds for the design of roads. These standards represent the various criteria, whose incorporation in the road design would achieve a desirable level of performance in average driving conditions. This is most true in terms of traffic safety, operation, economic effects, environmental effects and sustainability.

> *The first tier of the hierarchy specifies a desirable minimum value which would produce a high standard of road safety and which should be the initial choice. However, the level of service may remain generally satisfactory and a road may not become unsafe where these values are reduced. This second tier of the hierarchy is termed a Relaxation. The third tier of the hierarchy is known as a Departure from standard and is generally only applied in situations of exceptional difficulty.*[38]

The following provides a summary of the results of this analysis.

Horizontal Geometry

In relation to horizontal geometry, Table 3-2 outlines the minimum radius (R) requirements in relation to 100kph design speed roads. Table 3-3 and Figure 3-15 outline the results of the analysis for curves which are at or below the Desirable Minimum value of 720m. This highlights significant deficiencies with 29 curves at or below the threshold, which in design terms would require a departure from standard; moreover for demonstration purposes it is notable that the 18 curves recorded as being at, or less than 180m in radius, which would be a departure for a road with a design speed of 70kph.

These characteristics generally result in poor Stopping Sight Distance (SSD) along the route, a point which is expanded upon in section 3.5.2.2.5 of this report.

[38] DN-GEO-03031 (formerly NRA; DMRB, NRA TD9/12, February 2012)

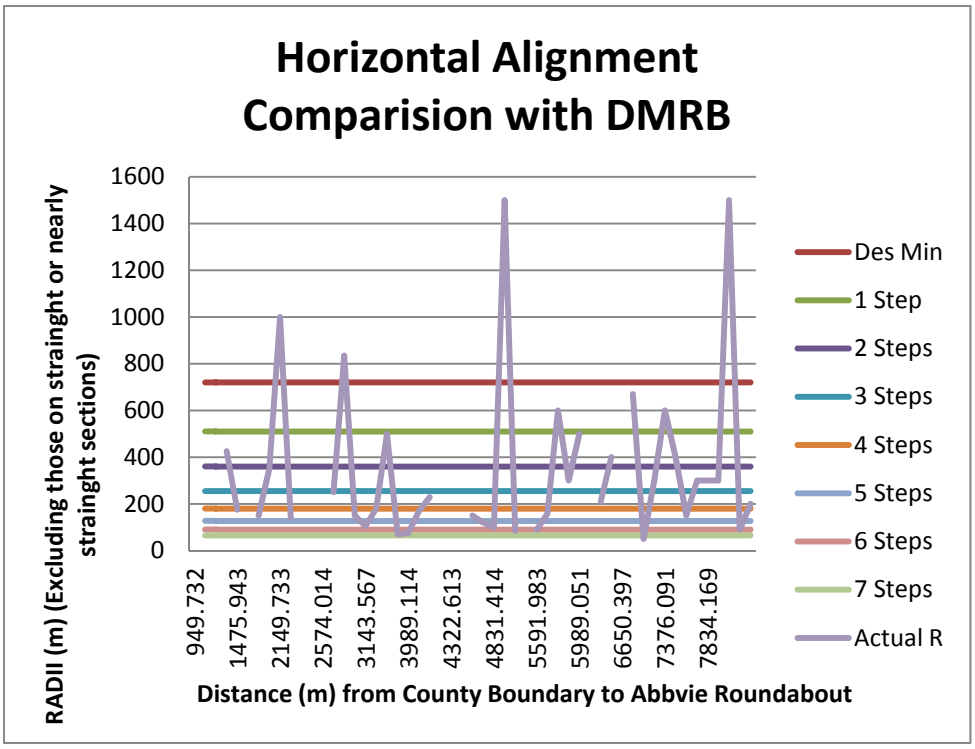
Table 3-2: DN-GEO-03031 (formerly NRA TD9; Design Speed related parameters (Horizontal Curves))

Horizontal Curvature m for Design Speed of 100kph	
Minimum R+ without elimination of Adverse Camber and Transitions	2040m
Minimum R+ with Superelevation of 2.5%	1440m
Minimum R with Superelevation of 3.5%	1020m
Desirable Minimum R with Superelevation of 5%	720m
One Step below Desirable Min R with Superelevation of 7%	510m
Two Steps below Desirable Min R with Superelevation of 7%	360m
Additional Curves which are outside the parameters of Table 1/3 of TD 09	
Three Steps below Desirable Min R with Superelevation of 7%	255m
Four Steps below Desirable Min R with Superelevation of 7%	180m
Five Steps below Desirable Min R with Superelevation of 7%	127m
Six Steps below Desirable Min R with Superelevation of 7%	90m
Seven Steps below Desirable Min R with Superelevation of 7%	90m

Table 3-3: Existing route Geometry in Comparison with Desirable Minimum R

Radius Band	720m	510m	360m	255m	180m	127m	90m	65m
Number of curves below particular band	37	34	29	23	18	8	6	1

Figure 3-15: Horizontal Alignment comparison of existing road with DMRB

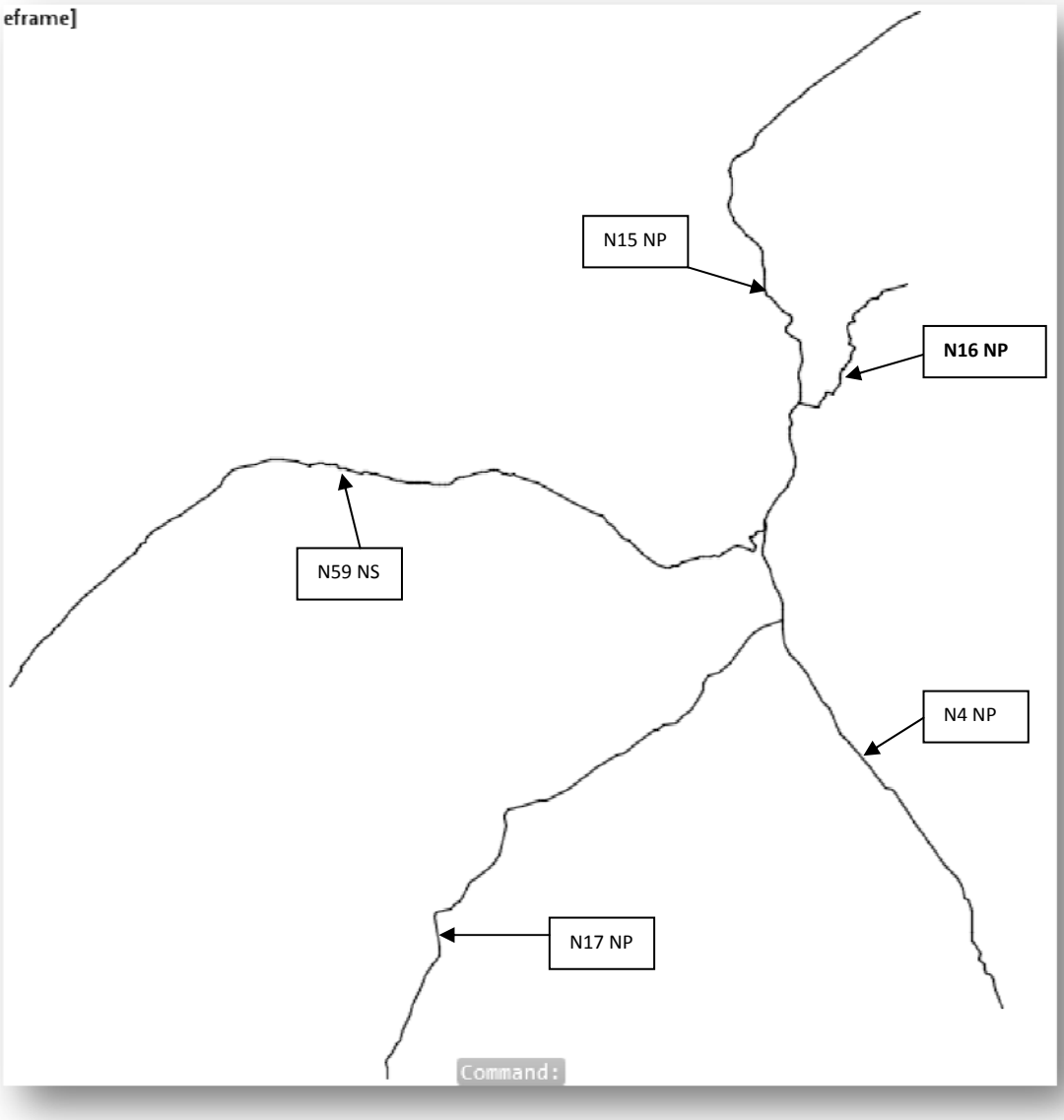


The deficient geometry occurs throughout the existing route and there are no clear sections where geometry could be considered to be at, or close to standard; by way of example the following outlines the most deficient sections:

- 110m Radius Bend at *Barroe*;
- 2 no. 180m Radius Bend's at *Barroe*;
- 100m and 300m Radius Bend's at *Barroe*;
- 2 no. 200m Radius Bend's at *Doonally*;
- 2 no. 90m Radius Bend's at *Drumkilsellagh*;
- 2 no. 90m and a 200m Radius Bends in *Drumkilsellagh* and *Castlegal*;
- 150m and 170m Radius bends in *Castlegal* and *Lugatober*;
- 70m and 80m Radius bends in *Lugatober*;
- 160m and 2 no. 90m Radius bends in *Lugatober* and *Lugnagall*;
- 160m and 120m Radius bends in *Lugnagall*;
- 300m, 200m and 100m Radius bends in *Lugnagall* and *Gortnagrelly*.

Sections, of such frequently occurring deficient radii, are quite uncommon on the national network. For demonstration purposes, Figure 3-16 outlines from a qualitative perspective how the N16 compares with other national routes in County Sligo. It is obvious from this figurative outline that the N16 has a higher frequency of twists, bends and tight radii than other routes within the County.

Figure 3-16: Sligo County National Primary and Secondary Network



Vertical Geometry

In relation to vertical geometry, Table 3-4 outlines the minimum requirements in relation to 100kph design speed roads. The analysis indicated a proliferation of various vertical curves along the route, with almost all curves coming under the category of a departure from standard for both the '*HOG*' and the '*SAG*' values. Similar to the demonstration made in relation to the horizontal geometry, it is notable that a significant portion of these curves have 'HOG' and 'SAG' values of below 10 which would be a departure for a road with a design speed of 70kph.

Table 3-4: DN-GEO-03031 formerly NRA TD9; Design Speed related parameters (Vertical Curves))

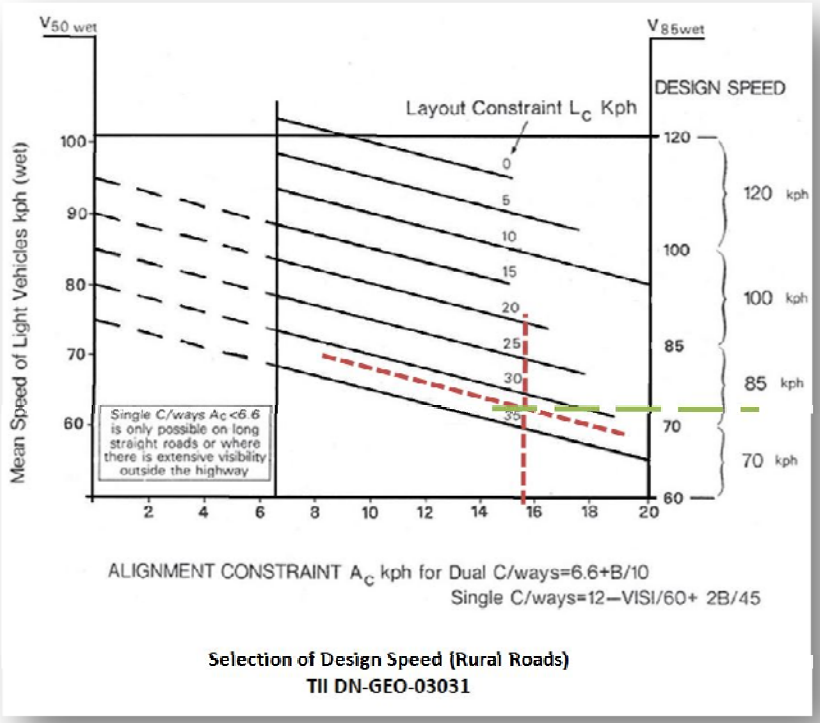
Vertical Curvature m for Design Speed of 100kph	
Des Min HOG	100
One Step below Des Min HOG	55

Vertical Curvature m for Design Speed of 100kph	
Two Steps below Des Min HOG	30
Des Min SAG	37
One Step below Des Min SAG	26
Two Steps below Des Min SAG	20

Design Speed Calculation

A design speed calculation has been carried out on the existing route to further characterise its deficiencies. This calculation has been carried out in accordance with TII DN-GEO-03031 (formerly TD 09/12) and reveals a design speed at the low end of the 85kph range which indicates a consequential Light Vehicle Mean Speed (wet) of circa 63kph which is well below the current day target for a national primary route.

Figure 3-17: Existing N16 – Design Speed



3.5.2.2.4 *Junctions*

Section 2.3 of this report, outlines the significant number of junctions with local roads along the existing route.

A significant safety issue in relation to these junctions (more particularly those rural ones) relates to the frequency of the junction, the Stopping Sight Distances which are attainable (in most instances well below the desirable minimum of 215m – see Table 3-5) and in a more isolated location the crossroads occurring at the N16's junction with the L-3407-0/L-3407-22 (see Figure 3-18).

Table 3-5: Junctions on Rural Section (3) of the existing N16

Junction Number	Section No.	Approx. Distance Ref. (Starting at junction with N4/N15) (m)	Townland Location	Stopping Sight Distance	
				SSD to the west/south	SSD to the east/north
L-3407-0	3	3572	*Doonally/Barroe*	64	140
L-3407-22	3	3572	*Barroe*	95	135
L-7416-0	3	5066	*Drumkilsellagh*	107	165
L-3406-0	3	5426	*Drumkilsellagh*	129	325
L-7415-0	3	6046	*Castlegal*	93	65
L-74151-0	3	6309	*Drum East*	90	160
L-7413-0	3	7103	*Lugatober*	86	195
L-34041-0	3	7748	*Lugatober*	220	163
L-3404-0	3	7831	*Lugnagall*	125	108
L-7411-0	3	9216	*Gortnagrelly*	190	347

Five of the junctions which are situated on bends are particularly dangerous such as that outlined in Figure 3-19.

There are approximately 65 agricultural entrances onto the existing rural section of the route. From a safety point of view, these types of entrances are especially problematic as they encourage slow moving and frequently heavy agricultural traffic onto the national primary network.

The increasing volumes of north-south/east-west traffic on this strategic route corridor will lead to a greater risk of road accidents and a significant loss of amenity to the local residential population.

Figure 3-18: Cross-roads at Doonally where vertical alignment is particularly poor

Figure 3-19: Junction with Drum Road (L-3406-0) which is a link to the N15 and is becoming increasingly busy

3.5.2.2.5 *Overtaking Opportunities and Stopping Sight Distance*

The Rural section from the AbbVie Roundabout to the county boundary has been assessed in terms of overtaking value as having only 3% over its c. 8.5km length. Stopping Sight Distance (SSD) in relation to junction accessibility has already been outlined in section 3.5.2.2.4. In relation to SSD on the mainline, it has been assessed from an exercise undertaken in MX Road that:

- 83% of the route does not achieve a desirable minimum of 215m;
- 69% of the route does not achieve a one step below desirable minimum of 160m;
- 54.4% of the route does not achieve a two step below desirable minimum of 120m;
- 41.4% of the route does not achieve a three step below desirable minimum of 90m;

These rather serious results are further compounded by the fact that junctions and house entrances occur frequently over much of the route, a fact which in new design circumstances would require the full desirable minimum value to be achieved.

The lack of overtaking opportunities and Stopping Sight Distance in combination with frequent junctions and accesses, many of which have restricted visibility is an unacceptable situation with regard to road safety.

The lack of hard stand/verge areas, coupled with agricultural activities which regularly, further limit the opportunities for vehicles to overtake as slower moving agricultural vehicles cannot move in to allow other vehicles to pass, resulting in long tailbacks particularly during spring and summer months. Similarly, vehicles that break down cause delays as there are limited opportunities to pass a stationary vehicle.

3.5.2.2.6 *Accidents*

The following tables and figures outline accident statistics downloaded from the Road Safety Authority website, for the period between 2005 and 2012. In general, it can be seen that there was one fatality occurring on the rural section of the N16 with a further 3 serious injuries on the urban section and 2 serious on the rural section. There have been a total of 38 reported accidents over the 8 year period on the N16 in County Sligo. Separately, although not documented below, it is notable that there was a further fatality in 2016 at *Drumkilsellagh*.

Table 3-6: RSA Collision statistics on URBAN section (2005 – 2012)

No. casualties - fatal	0
No. casualties - serious	3
No. casualties - minor	21
No. casualties - total	24

Table 3-7: RSA Collision statistics on RURAL section (2005 – 2012)

No. casualties - fatal	1
No. casualties - serious	2
No. casualties - minor	11
No. casualties - total	14

Figure 3-20: RSA Accidents; Sligo to Doonally

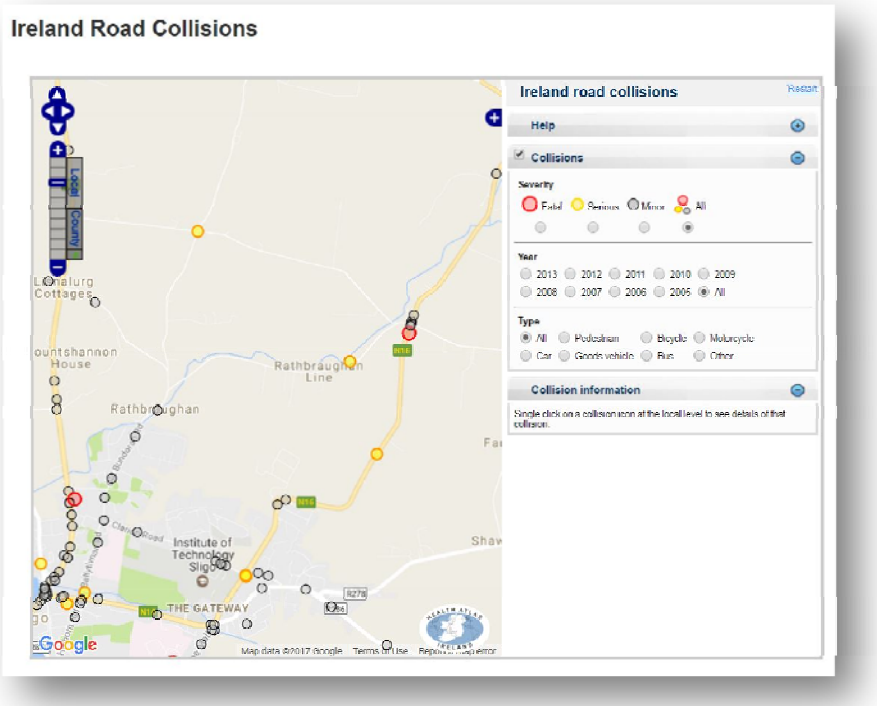


Figure 3-21: RSA Accidents; Doonally to Collinsford

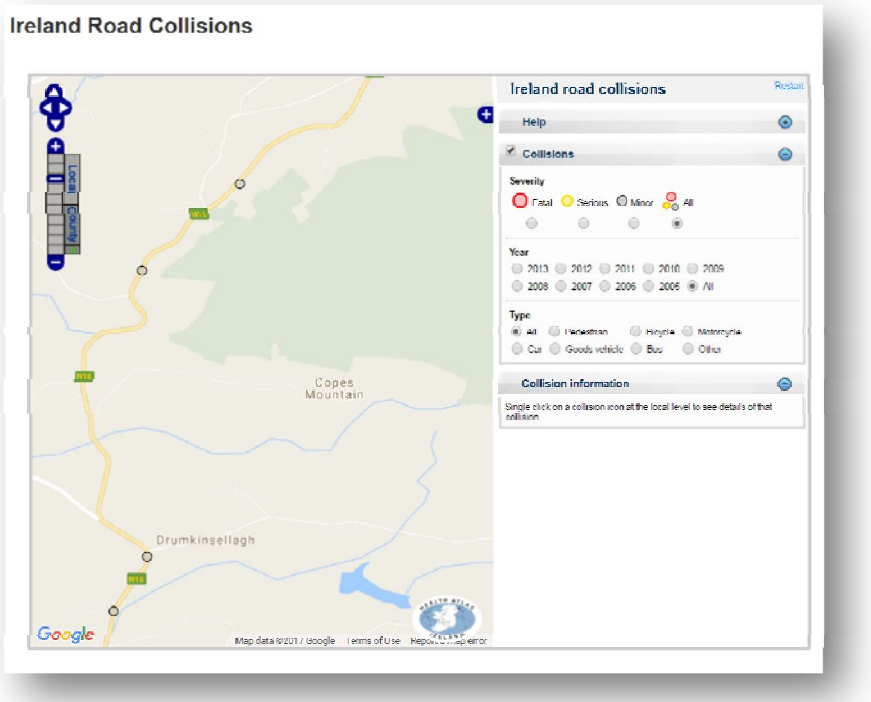
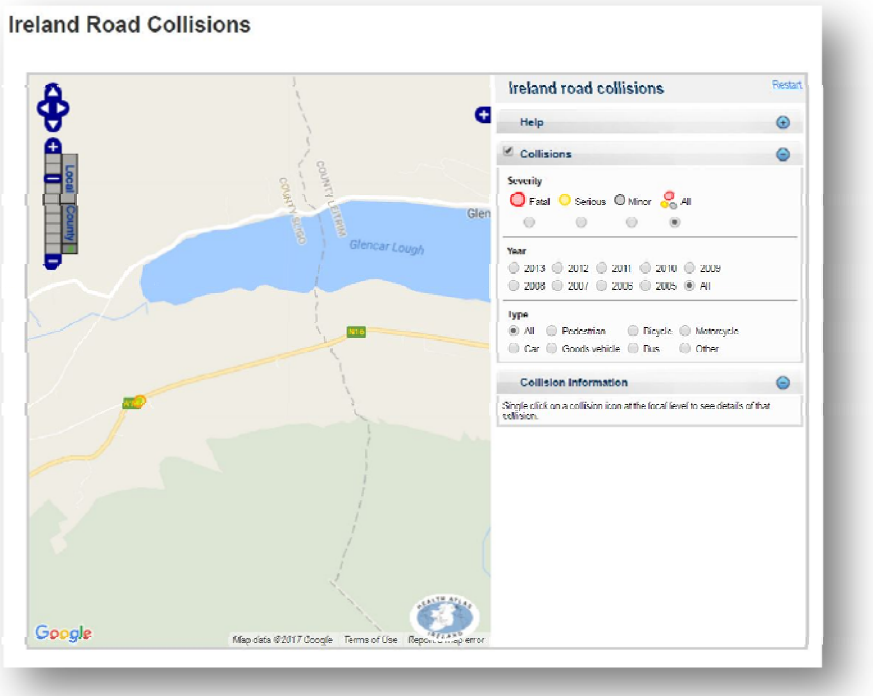


Figure 3-22: RSA Accidents; Collinsford to County Boundary



3.5.2.2.7 *Collision Rates*

Collision Types

Based on information obtained from RSA statistics, Table 3-8 outlines the type of circumstances prevalent in the various collisions. From this, it is notable that *'Rear end, Straight'* and *'Angle'* accidents are significantly above the national averages (although these are based on fatal accidents). This may be caused by poor visibility on sections of the existing road. Interestingly, pedestrian accidents are below the national average, possibly indicating the limited use by cyclists and pedestrians of the route.

Table 3-8: Collision Type

Circumstances	No.	% of Total	National average for fatal accidents
Other	3	13%	10%
Rear end, straight	4	17%	3%
Angle	6	26%	5%
Pedestrian	2	9%	27%
Single vehicle only	8	35%	40%

Fatality and Collision Rates

In terms of fatality rates the RSA states that:

In 2010, the fatality rate per billion vehicle kilometre travelled was 4.5. The 2000 rate was 12.6.[39]
In 2011, the fatality rate per billion vehicle kilometre travelled was 3.9. The 2001 rate was 11.9.[40]

These rates are significantly lower than the extrapolated rate for the rural section of the N16; which as outlined in Table 3-11 is 13.05 fatalities per billion vehicle km travelled.

The collision rate for rural 2 lane roads nationally, between 2008 and 2010, is 11.3 collisions per 100 million km of travel. The collision rate per 100 million km of travel on the N16 is 24.488 (urban and rural combined).

Table 3-9: Vehicle km travelled per N16 Sligo Section (Urban and Rural)

veh km travelled per N16 Sligo Section	
Total Length (km)	10.45
Total veh km per year	11740261.5
Total veh 1mil km per year	11.7402615
Total veh 100mil km per year	0.117402615
Total veh 1bil km per year	0.011740262

Table 3-10:Collision Rate per vehicle km (Urban and Rural combined) of travel on N16

Collisions per veh Km of travel on N16	
Total Collisions	23
Avg Collisions per 1 year	2.875
Collisions per million Km	0.24488
Collisions per 100 million Km	24.488
Collisions per 1 billion Km	244.883

Table 3-11: Collision Rates on Rural section of N16

Total length, Rural	8.52km
AADT	3078 veh/day
Billion km travelled per year	0.009575784
Fatalities per year	0.125
Fatalities per b km	13.05376118

Considering the length of the existing N16 between Sligo and the boundary with Northern Ireland, and the AADT on the route, the RSA have prepared the information as outlined in Table 3-12.

[39] *Road Collision Facts, 2010;* Road Safety Authority

[40] *Road Collision Facts, Ireland, 2011,* Road Safety Authority

Although overall accidents are relatively low on the N16 when compared with other routes, the accident rate, per 10^6 vehicle kilometre travelled, is the seventh highest out of the 50 National Primary Routes based on 2012 data. In 2010, it had the second highest national collision rate of all National Primary roads.

Table 3-12: Road Collision Facts, 2012; Road Safety Authority

Table 51 Fatal and Injury Collisions on National Routes Classified by Route and by Location Type

	Inside Built-up Areas				Outside Built-up Areas					
National Route	F	SI	MI	Total	F	SI	MI	Total	Overall Total	Rate per 10^6 Veh. Km*
N1	0	0	33	33	0	2	19	21	54	0.10
N2	0	0	30	30	3	1	16	20	50	0.10
N3	1	2	29	32	1	2	16	19	51	0.07
N4	1	0	36	37	3	3	37	43	80	0.07
N5	0	0	6	6	1	5	27	33	39	0.13
N6	0	3	11	14	0	1	26	27	41	0.06
N7	0	0	7	7	0	1	36	37	44	0.03
N8	0	0	10	10	1	1	23	25	35	0.05
N9	0	0	0	0	1	1	20	22	22	0.05
N10	0	0	1	1	0	0	5	5	6	0.05
N11	0	2	38	40	2	5	46	53	93	0.10
N12	0	0	2	2	0	0	0	0	2	0.09
N13	0	0	1	1	1	0	9	10	11	0.08
N14	0	0	2	2	1	0	13	14	16	0.28
N15	0	1	1	2	3	7	24	34	36	0.14
N16	0	0	1	1	0	0	5	5	6	0.12
N17	1	1	13	15	2	2	20	24	39	0.11
N18	1	0	4	5	1	1	19	21	26	0.06
N19	0	0	2	2	0	0	2	2	4	0.09
N20	0	0	10	10	1	1	15	17	27	0.06
N21	1	2	13	16	0	3	15	18	34	0.11
N22	1	1	24	26	1	3	11	15	41	0.11
N23	0	0	1	1	0	0	2	2	3	0.14
N24	0	1	12	13	2	1	23	26	39	0.10
N25	0	1	19	20	3	5	30	38	58	0.06
N26	0	0	4	4	1	1	2	4	8	0.13
N27	0	0	0	0	0	0	1	1	1	0.02
N28	0	0	1	1	0	0	3	3	4	0.06
N29	0	0	0	0	0	0	0	0	0	0.00
N30	0	0	2	2	0	0	5	5	7	0.12
N31	0	0	7	7	0	0	1	1	8	0.16
N32	0	0	1	1	0	0	0	0	1	0.02
N33	0	0	0	0	0	0	1	1	1	0.09
M50	0	1	13	14	0	1	41	42	56	0.08
TOTAL	6	15	334	355	28	47	513	588	943	0.08

TII HD 15 Network Safety Ranking

Notwithstanding the foregoing, GE-STY-01023 (formerly HD 15) of the DMRB covers the requirements for Network Safety Ranking on National Roads. This safety ranking system is a means for identifying, analysing and classifying parts of the existing road network according to its potential for safety improvement and accident cost savings. (EU, Road Infrastructure Safety Management Directive). This Ranking procedure identifies High Collision Locations as being sites on the Network which has a collision rate twice above the average

In relation to the N16, the Network Ranking procedure over the periods 2011 – 2013 (See Figure 3-23) and 2012 – 2014 (See Figure 3-24), has identified High Collision Locations in the following areas on the existing network:

(1) *Ballytivnan*;

(2) *Barroe* and *Doonally*;
(3) *Drumkilsellagh*; and
(4) Lugatober

Figure 3-23: TII Collision Rates 2011-2013[41]

Figure 3-24: TII Collision Rates 2012-2014

[41] Red lines indicate accidents locations which are twice above the national average. Blue lines indicate accident locations which are twice below the national average.

4 Scheme Objectives

4.1.1 Scheme Objectives

The overarching objective in relation to the N16 is to align the design speed of the N16 with national standards and in so doing to ...*secure the provision of a safe and efficient network of national roads...* as is required in the Roads Act.

As the route selection process evolved and the number of viable route options reduced, the intensity and scale of the assessment increased.

In the Stage 1, Preliminary Options Assessment (sections 9 and 10 of this Route Selection Report) the objectives were measured under the headings of Engineering, Economics and Safety as recommended by the TII Project Appraisal Guidelines and the Project Management Guidelines. In Stage 2 (Project Appraisal), the objectives of the scheme were appraised in accordance with the national transport planning policy, using the common appraisal framework and the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

Economy

The N16 is a key national and cross border corridor and delays to traffic have a negative impact upon the economy. The economy objective is concerned with improving the economic efficiency of transport and providing economic transport solutions.

It is an objective of the proposal to decrease average journey times in order to achieve a Level of Service D in the design year. A Level of Service D, approximately equates to an average inter-urban speed of 80 km/h. This will reduce journey times and improve journey time reliability, both of which will generate positive economic benefits to businesses and consumers.

Economic efficiency and effectiveness is measured by the willingness-to-pay of the consumer, the financial impact on transport providers and the effects on government finance. These factors are captured through Cost Benefit Analysis (CBA). CBA analyses how projects could increase overall welfare, after allowing for economic costs. If Benefits exceed Costs, or if the Benefits/Costs ratio exceeds 1, then the project should add to overall welfare of society.

The key measure of Efficiency and Effectiveness to be used in the Multi Criteria Analysis (MCA) is the transport user related Present Value of Benefits (PVB).

Safety

The safety objective aims to reduce loss of life, injuries and damage to properties resulting from transport collisions.

It is an objective of the route corridor improvement to replace the existing deficient section of the N16 with a Type 2 Single Carriageway, consistent with the standards set out in the TII Design Manual for Roads & Bridges. It is also proposed, to as far as is possible, segregate and reduce the number of direct accesses onto the route and to ensure the safe provision of facilities for Non-Motorised Users.

This will reduce the accident rate by improving the existing geometry which is significantly deficient.

Environment

The realignment of a road corridor, by its nature will have impacts on the existing environment. It will be an objective of the proposal to maintain these impacts, to as an acceptable level as is possible, while still achieving other objectives.

It will also be an objective of the proposal to improve the existing environment where that is possible. This will include *inter-alia:* improved water quantity and quality treatment measures, improved amenity benefits for those properties in the vicinity of the existing N16 and improved amenity benefits for vulnerable road users.

Accessibility and Social Inclusion

The proposal will improve road based public transport at a local, regional and national level, by improving safety along this section of the N16 corridor.

The project will seek to improve facilities for those without a car and to reduce access severance.

Integration

Integration aims to ensure that all decisions are taken in the context of wider European directives and national government policy objectives, and the impact of a scheme in terms of transport provision (e.g. provision of missing links), land use integration (e.g. compatibility with national / local land use strategies) and geographic integration (e.g. does the scheme improve transport links to Northern Ireland and Europe).

It is an objective of the proposal to improve existing connections to regional hubs and gateways. This will support the objectives of the National Spatial Strategy in terms of achieving balanced regional development. Additionally, the EU has designated the N16 as part of the comprehensive network of routes which support the core network of the Trans European Road Network. In this regard, improvements to the N16 will support the objectives of the TENT.

Physical Activity

The proposal, via the provision of dedicated cycle/pedestrian tracks (whether online or offline) will provide a positive benefit for pedestrians and cyclists who will utilise the services provided.

iv. CONSTRAINTS

5 Constraints

5.1 Introduction

The initial step in the Route Selection Process is to identify the nature and extent of significant constraints within a defined Study Area.

The Constraints Study phase of the project is concerned with gathering together as much information as possible relating to the area of interest. The data collection is focused on determining what constraints exist which could influence the choice of route location for the proposed scheme. These constraints are outlined in the following section of the Route Selection Report.

5.2 Mapping and Topography

5.2.1 Mapping

Detailed mapping for the purposes of Route Selection, has been used under a licence agreement with the OSi. The mapping used includes combinations of the following:

- 1:50,000 OSi discovery series mapping;
- Current editions of the 1:5,000/1:2,500 and 1:1,000 scale OSi vector mapping;
- Current editions of the OSi's ortho-photography (aerial survey) mapping;
- Historical raster versions of the both the six-inch scale and 1:2,500 scale OSI mapping;

5.2.2 Topography

In order to establish designs for the purposes of Route Selection, an appreciation is required of the existing ground topography. The topography of the wider landscape was established utilising vector mapping in contour format, to a scale of 1:10,000 and an accuracy of +/- 5m. This was enhanced with site specific LiDAR (Light imaging Detection and Ranging) data for the overall Constraints Study Area. Varying vertical accuracies of LiDAR information were achievable within the study area and generally ranged from +/- 0.10m to =/- 0.20m. This level of accuracy is suitable for the purposes of Route Options design.

5.2.3 Windshield Survey

A windshield survey was carried out to compliment the available mapping and to gain an insight into the level of development, which has taken place in recent years.

5.3 Natural Constraints

5.3.1 Introduction

Natural Constraints refer to those naturally occurring landscapes and features within the Study Area.

5.3.2 Landscape & Visual

5.3.2.1 Study

The Landscape and Visual Assessment aspect of the Route Selection Report has been carried out by RPS Ireland Ltd. The following sections describe Constraints identified as part of this assessment.

5.3.2.2 Landscape

The proposed study area extends along the corridor of the existing N16 road corridor from Sligo to the County Boundary with Leitrim and is located to the northeast of Sligo.

The topography along the existing N16 road rises gradually from its lowest level adjacent to Sligo City (approx. 50mASL) to its highest level above Glencar Lake (approx. 130m ASL). In between the existing road undulates significantly and meanders as well across and around small undulations in the topography.

The topography within the study area is dominated by the tall massive mountains that lie to the north and south of Glencar Lake. To the north the range of mountains at their closest are represented by Kings Mountain that extends to 469m ASL. To the south of Glencar Lake lies another range of mountains that at their closest has Copes Mountain that extends to 452m ASL. Both sets of mountains are very distinctive to this part of Sligo and Leitrim and have fairly level summits and steep and rocky side slopes. These steep and rocky side slopes in close proximity to the lowlands and particularly Glencar Lake create a highly scenic landscape. Due to the difficulty of access there are few to no residential properties and roads on the high landscapes.

Glencar Lake is dominated to the north and south by the high mountains and the sense of enclosure is strong due to the narrowness of the valley created in between. The existing N16 road extends to the south of the Lake and as it sits at a higher level in the topography is afforded views to the north across the Lake and the escarpments and summits of Kings Mountain beyond. There are several small County Roads in and around the Lake and a number of residential properties on the northern side of the Lake.

To the west of Glencar Lake the topography broadens out to form a lowland landscape. The Drumcliff River continues to meander west. The topography of this broader lowland landscape undulates with the majority of contours running east – west which most likely reflects the processes of glaciation during the last Ice Age. There are numerous small County roads criss-crossing the lowland landscape and frequent rural residential properties. Properties increase in frequency with proximity to Sligo City.

5.3.2.3 Landscape Character

The distinctiveness of different landscape characters in the study area can be sub-divided into four distinctive landscape character areas (see Figure N16-RS-081 in Volume 5) as follows:

1. Sligo Lowland Agricultural Landscape
2. Sligo Urban Landscape
3. Glencar Lake Valley Landscape
4. Copes Mountain Upland Landscape

5.3.2.3.1 *Sligo Lowland Agricultural Landscape Character Area*

A broad lowland landscape is located between the upland mountains of Kings Mountain and Copes Mountain through which Drumcliff River flows west towards the Atlantic. This lowland landscape gently undulates but is predominantly low-lying and in places almost level particularly in close proximity to the river. The undulations in the landscape are generally gentle but are steeper with proximity to the uplands to the east. The undulations are predominantly aligned in an east to west axis. The landscape is also predominantly pastoral in land use with sheep and beef cattle grazing. Hedgerows are well maintained and vary from thin with post and wire to substantial hedgerows with trees. The hedgerows are stronger with more frequent trees with proximity to Glencar Lake and thinner to the west. There are also frequent trees along small streams that flow west including along

the small stream that flows west from the reservoir near Willowbrook. Residential properties are scattered through the lowland landscape but greater in frequency with proximity to Sligo to the southwest of the study area and also with proximity to the N15 road corridor to the west of the study area.
This landscape character area has a medium sensitivity to the type of change proposed.

5.3.2.3.2 *Sligo Urban Landscape Character Area*

Sligo is one of the largest urban centres in the northwest of Ireland and serves a wide hinterland acting as a regional hub. The City has historically grown on the banks of the River Garvogue in an undulating landscape. The river flows west to Sligo Bay and the Atlantic. The undulating landscape on which the City has grown has resulted in a prominent built form that offers views north across the lowland landscape and upland mountains beyond. The core of the City is retail dominated with shopping streets including Wine Street; O'Connell Street; Grattan Street; Stephen Street; Castle Street and Market Street. The northern side of the City has a mixed use of residential, educational and industrial uses. There are 2 AbbVie pharmaceutical plant's, located on the northern edge of the City, with the Rathbraghan campus situated adjacent to the N16. Similarly there are extensive grounds for the Institute of Technology Sligo in this northern area as well as the Clarion Hotel. The remainder of the urban landscape consists of residential land use with properties lining the N16 road corridor and small housing estates frequent.
This landscape character area has a low sensitivity to the type of change proposed.

5.3.2.3.3 *Glencar Lake Valley Landscape*

Glencar Lake lies in the Glencar Valley, between the Dartry Mountains to the north and the mountain range including Cope's Mountain to the south. The lake is located about 10 kilometres northeast of Sligo and is approximately 2.5 km long and 0.6 km wide. The Lake is located in a narrow valley constrained to the north and south by upland landscapes that provide a sense of enclosure.

The Lake is known to contain two crannogs at the western and eastern ends of the Lake. The Lake is fed by Glencar Waterfall, on the lake's northern shore, and by the Diffreen River to the east. The Lake flows west to Drumcliff River which in turn flows west to Sligo Bay and the Atlantic. The Lake mostly lies with Leitrim. The Glencar Waterfall is a tourist attraction and lies within Leitrim. W.B.Yeats referred to the Glencar Waterfall in his poem "the Stolen Child".

A small County Road is found on the northern shoreline and offers views south over the Lake to Copes Mountain and west along the valley towards the distinctive summit of Benbulben. It is important to note that the existing N16 road is located within views from the lake shore road and existing traffic particularly HGV's are visible in views.
There are scattered residential properties along the northern shoreline that are readily visible from the N16 road corridor.
This landscape has a high sensitivity to the type of change proposed.

5.3.2.3.4 *Copes Mountain Upland Landscape Character Area*

The upland landscapes adjacent to the existing N16 are very good examples of the distinctive uplands found in Sligo and western Leitrim with apparently level summits and steep sides with frequent rocky escarpments. The steep side slopes occasionally consist of forestry but predominantly the side slopes are limited in vegetation to grass which contrasts strongly with the rocky outcrops. The uplands are highly scenic and their value is recognised by designations in both Leitrim and Sligo Development Plans. The uplands are also valued by hill walkers and there are several promoted long distance walks.

The uplands offer panoramic views across Glencar Lake and west towards Sligo and the sea. It should be noted that as there are no roads that cross these uplands such views are limited to the infrequent hillwalkers that use the upland trails. There are no residential properties within the upland landscapes. This landscape has a high sensitivity to the type of change proposed.

5.3.2.4 Landscape Quality

Highest Quality:- the landscapes of highest quality are, by definition, landscapes of an 'awe inspiring' or 'sublime' nature and are important on an international and national level. The Copes Mountain Upland Landscape Character Area is determined by this landscape assessment to fall within this classification within the study area.

Very Attractive:- this definition relates to landscapes which are still of high value nationally and can be defined as highly scenic. This landscape assessment has determined that the Glencar Lake Valley Landscape is within this category.

Good Landscape:- this category contains areas which, although still attractive, have less significant and more common landscape features. They contain more intrusive elements such as residential developments and conspicuous infrastructure. This category includes the Lowland Agricultural Landscape Character Area.

Ordinary Landscape:- this category contains areas which have only common landscape features and high levels of intrusive elements such as residential developments and conspicuous infrastructure. This category includes the Sligo Urban Landscape within the study area.

Poor Landscapes:- There are no landscapes within this category.

5.3.2.5 Visually Significant Trees

There is limited vegetation cover within the study area with potential to be effected by the proposed route options. This shortage of potentially visually significant vegetation results in increasing the value of such vegetation where it does occur in the study area. In summary the key areas of visually significant vegetation are as follows;

- Woodland block west of N16 between AbbVie factory and the Veterinary laboratory;
- Vegetation west along the stream north of Rathbraghan Park (L-7422-0) road from N16;
- Vegetation north and east of the L3407-22 road;
- Woodland block northeast of L3407-22 and junction with N16;
- Vegetation along a private lane east of the N16 and Fawcett's Bridge as well vegetation north of a private house;
- Coniferous forestry woodland between the L7416-0 and the L7415-0;
- Strong tree lined hedgerows immediately north of the L74151-0 and between the N16 and the L7421-0;
- Woodland on both sides of the N16 and a sharp bend on the N16 near Castlegal;
- Woodland north and south of the N16 at its junction with the L3404-1 and the L3404-0;
- Woodland and forestry along the Drumcliff River corridor;
- Small woodland belt south of the N16 and south of Gortnagrelly Bridge;
- Woodland along small stream towards Drumcliff River from the N16 and across the L7411-0;
- Woodland between the N16 and Glencar Lake on both sides of the County Boundary;
- Coniferous forestry blocks south of the N16 between the viewpoint car park and the County Boundary;

5.3.2.6 Landscape Designations

The relevant Development Plan for the proposed scheme is the Sligo County Development Plan 2011 - 2017. The Development Plan was reviewed as part of this assessment to establish any landscape and visual policy or designations relevant to this assessment. As the proposed route options extend to the County Boundary with Leitrim in addition to a review of the Sligo Development Plan a review has also taken place of the Leitrim County Development Plan 2015 – 2021.

5.3.2.6.1 *Sligo County Development Plan 2011 - 2017*

The following relevant landscape designations have been identified. The various route options run through normal rural landscape and scenic routes. Policies have been put in place by the development plan such as P-LCAP-5 – to protect and enhance the visual qualities of rural areas through the sensitive design of necessary development. Sligo County Council objectives include; O-LCAP-3 - Seek to preserve the landscape character of County Sligo by assessing all development proposals against the provisions of the Landscape Characterisation Map (Fig 7.D of the County Development Plan). Planning applications that have the potential to impact significantly and adversely upon landscape character or scenic views may be required to be accompanied by a visual impact assessment using agreed and appropriate viewing points and methods for the assessment. The proposed new development must follow alongside policy P-LCAP-11 which aims to preserve the importance of traditionally open/unfenced landscapes. It states that fencing in upland or amenity areas will not normally be permitted unless such fencing is essential to the viability of the farm and conforms to best agricultural practice. Also following policy P-LCAP-7 which seeks to have regard to potential environmental impacts of new infrastructure/industrial development, such as noise and air pollution impinging on views, tranquillity and character, and the consequences that such development may have for the evolution of settlements.

Landscape Assessment and Protection

Section 7.4.3 of the Plan sets out a range of landscape areas and scenic routes for development control purposes. It includes; Normal Rural, Sensitive Rural Landscapes and Visually Vulnerable Areas. Figure 7.D - Landscape Characterisation Map indicates the location of the range of landscape areas and scenic routes.

The Normal Rural Landscapes are characterised as areas with natural enclosing features (e.g. topography, vegetation), which have the capacity to absorb a wide range of new development forms – these are the main farming areas of the County. The Sensitive Rural Landscapes are areas that tend to be open in character, with intrinsic scenic quality and a low capacity to absorb new development. The study area covers both normal and sensitive rural landscape areas. The sensitive rural landscape area is the Cope's Mountain area.

The Development Plan has objectives relating to these landscapes that includes:

- O-LCAP-5 Strictly control new development in designated Sensitive Rural Landscapes, while considering exceptions that can demonstrate a clear need to locate in the area concerned;
- O-LCAP-6 Ensure that any new development in designated Sensitive Rural Landscapes: — does not impinge in any significant way on the character, integrity and distinctiveness of the area; — does not detract from the scenic value of the area; — meets high standards of siting and design; — satisfies all other criteria with regard to, inter alia, servicing, public safety and prevention of pollution.

Visually Vulnerable

The Landscape Characterisation Map shows (Fig 7.D) areas that are visually vulnerable which are described as distinctive and conspicuous natural features of significant natural beauty or interest; they also have an extremely low capacity to absorb new development. The Map has proven robust in assisting development and protecting fragile landscapes. The designation of Scenic Routes provided a basis for protecting views and prospects of certain Visually Vulnerable features. Objective O-LCAP-4 of the plan aims to discourage any developments that would be detrimental to the unique visual character of designated visually vulnerable areas.

There is a visually vulnerable area to the northern part of the study area. This shows the visually vulnerable Cope's Mountain area. To the north of this northern part of the study area there is a visually vulnerable area that covers Glencar Lake.

Scenic Routes

The Plan has designated a series of Scenic Routes that forms the basis of protecting views and prospects of certain Visually Vulnerable features. It is objective O-LCAP-7 of the CDP to preserve the scenic views within Appendix G of the Plan, this is done by controlling all development along designated scenic routes. Appendix G of the Plan lists all of the Scenic Views to be preserved while Scenic Routes are indicated on Figure 7.D - Landscape Characterisation Map. The nearest Scenic Route and Scenic Views to any of the proposed options are:

National Primary Routes-

- N15 from Bunduff Bridge (Leitrim County boundary) to Sligo that preserves views of Atlantic Ocean, Benbulben, Kings Mountain and Benwiskin;
- N16 from Leitrim County boundary to Sligo that preserves views of Glencar Lake, Benbulben and Atlantic Ocean;

Regional Routes-

- R291 from Sligo to Rosses Point preserving views of Sligo Bay and Harbour, Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Daeane, Killery Mountain and Ox Mountains.

Local Roads-

- L-3311 as far as junction at Yeats County Hotel turning south onto Rosses Point Promenade Road (R291) to mini-plan development limit preserving views of Sligo Bay and Harbour Coney Island, Knocknarea and Coolera Peninsula, Slieve Dargan, Slieve Deane, Killery Mountain and Ox Mountains;
- Glencar Lake to Carney (L-3404, L-3403 & L-3402) protecting views of Glencar Lake, Kings Mountain and Benbulben;
- From the junction of the L-3409 and the R286 at *Ballynamona*, northwards through *Loughanelteen* to *Keelogyboy* (L-3409 & L-7418), then south to R278 via *Fermoyle* (L-7420 & L-3407) that preserves views of Keelogyboy Mountain, Cope's Mountain, Lough Anelteen, Killery Mountain, Lough Gill, Ox Mountains, Slieve Deane, Slieve Dargan, Kings Mountain, Benbulben, Knocknarea, the coast, Sligo Bay and Atlantic Ocean;
- Glencar Lake to N16 (L-3404) protecting views of Glencar Lake and Kings Mountain.

5.3.2.6.2 *Leitrim County Development Plan 2015 - 2021*

The relevant Development Plan for the proposed scheme is the Leitrim County Development Plan 2015 - 2021. The Development Plan was adopted on the 12th January 2015 and came into effect on the 9th February 2015. It was reviewed as part of this assessment to establish any landscape and visual policy or designations relevant to this assessment. The following relevant landscape designations have been identified.

Areas of Outstanding Natural Beauty (AONB)

Areas of Outstanding Natural Beauty are identified on Map 3.12 in the Plan. It is Policy 100 of the Council to permit development within an AONB where the applicant can assure the planning authority that it is not practicable to develop in a less-sensitive location. The AONB of Aroo, Glenade, Truskmore, Glencar and environs is referenced as A3 on Map 3.12 of the Plan and is overlapping with the proposed development.

High Visual Amenity

It is the policy of the Council, *"to permit development in an area of High Visual Amenity only where the applicant has demonstrated a very high standard of site selection, site layout and site design and where the planning authority is satisfied that the development could not be accommodated in a less-sensitive location."* The proposed routes do not enter into any high visual amenity areas.

Protected Views and Prospects

The Plan has designated a number of protected views and prospects that are made up primarily of the County's lakes and upland areas from public roads. The Council has an objective to protect all views and prospects which it lists in Table 20 of the Plan and illustrates the locations on Map 3.12 of the Plan. The map shows the two nearest Protected Views to be V8 which has views towards Glencar Lake from Local Road LP04145 and V9 showing views towards Glencar Lake from the N16. Leitrim County Council Policy 102 aims to protect these views from intrusive development and enhance them by the removal of dereliction.

Landscape Character

The Leitrim County Council have completed a Landscape Character Assessment report and this has been reviewed to establish the nearest and most relevant landscape character areas to the proposed study area. The location of all landscape character areas are shown on Figure 6 of the report. There are three areas that are overlapping or adjacent to the proposed study area and these are; LCA 5 - Tievebaun Uplands, LCA 6 -The Doons and Crockauns and LCA 9 - The Northern Glens, Central Lowlands and Lough Allen.

5.3.3 Hydrology, Hydrogeology, Water Quality and Fisheries

5.3.3.1 Hydrology

5.3.3.1.1 *General Description of N16 Study Area*

Within the Study Area there are four relatively small river/stream basins which discharge westwards to the coast and into Sligo Harbour. The topography can be split into steep hill slope lands off Cope's

and Keelogyboy Mountains to the east and northeast of the existing N16. These steep sloping lands continue northwest and north towards Glencar Lough and the Drumcliff River valley. To the west and south west of the N16, moderate to gentle sloping lands are present which become more gentle in gradient towards the coast. The ground levels within the study area and along the proposed route options increase northwards, with the Southern section near Sligo being typically at 10 to 20m OD and increasing to 70 to 80m OD in the central section in the vicinity of the existing N16 road at *Drumkilsellagh* townland and then following the 70 to 100mOD contours along the western and northern side of Cope's Mountain to the Leitrim Border.

The rainfall increases with altitude west to east with typical annual average rainfall amounts of 1200 to 1300mm along the coastline area and increasing to 1300 to 1500mm in the vicinity of the existing N16 and reaching levels of 1800 to 1900mm towards the summit of Copes Mountain and Crockauns. The catchment average annual rainfall is 1790mm for the Drumcliff River, 1650mm for the Willsborough Stream, 1260mm for the Cregg Stream and 1340mm for the Drumcliff-Glebe stream. Evapotranspiration rates are approximately 500mm per annum.

5.3.3.1.2 *Drainage Features*

The largest river basin is the Drumcliff River catchment to the north of the Study area having a total catchment area of approximately 61.3km^2 and discharges into Drumcliff Bay. To the south of the Drumcliff Basin, a small Stream, the Drumcliff-Glebe Stream, drains a catchment area of some 7km^2 and also discharges into Drumcliff Bay. The Cregg Stream (catchment area of 5.4km^2) and the Willsborough Stream (catchment Area 19.2km^2) located further to the south of the study area discharge into the Garvogue Estuary. The Willsborough Stream is the Outflow from the Kilsellagh Reservoir and Dam. South of the Study Area the Garvogue River which is the outflow from Lough Gill flows westward into the Garvogue Estuary and Sligo Harbour. The total catchment area of the Garvogue River is 369km^2. Lough Gill which is 12.8km^2 in area and typically at an elevation of 7m OD is a major source to the Sligo Public Water supply. This lake is located up-gradient of the N16 Study Area at Sligo City and outside of the hydrological zone of influence of the proposed route options.

Glencar Lough at the north end of the scheme lies in the Glencar Valley, between the Dartry Mountains to the north and the mountain range of the Crockauns and Cope's Mountain to the south. Glencar Lough is primarily fed by Glencar Waterfall, on the lake's northern shore, and by the Diffreen River, entering at the lake's eastern end. The lake drains west into the Drumcliff River, which in turn flows into Sligo Bay. This is a steep sided valley and has a well defined flood zone and permanent lake area (1.15km^2). This lake performs a major attenuation function for the Drumcliff River significantly attenuating the surface runoff from the Hillslopes to the north and South. The Glencar Lough is at a typical elevation of 26m OD and it along with the Drumcliff River are located sufficiently downgradient of the Study Area as not to represent a direct flood risk to the various routes. The Northern Section of the Study Area which for topographical reasons is confined to a narrow band width of 300 to 400m close to the existing N16 road alignment traverse numerous small hillslope tributaries of the Drumcliff River and Glencar Lough (5 main tributaries and numerous smaller drainage channels). It should be noted that the status of Glencar Lough is extremely high (International) being within the Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). The Drumcliff River that forms the outflow from Glencar Lough is not within the SAC and would have a local higher ecological status being considered a fishery stream and discharging into the Drumcliff Bay SAC.

The ecological status (Q-Rating) of these streams is reported to be 'Poor' for the main Drumcliff River channel both downstream and upstream of Glencar Lough (possible agricultural drainage impacts) but has good status in respect to Physio-chemical water quality testing. Glencar Lough is classified to be of good water quality status having oligotrophic/mesotrophic status. The head

waters of the Willsborough Stream are classified as being of high ecological status including the main upstream Kilsellagh inflow stream. The main channel of the stream from the Kilsellagh reservoir downstream to the sea is also recorded as being of 'Good' Status. There is no classification for the Drumcliff-Glebe Stream being a small drainage channel and of little ecological value. The Cregg stream which receives a treated sewage discharge from the Cregg Village area is classified (by extrapolation) to be of 'moderate' ecological status.

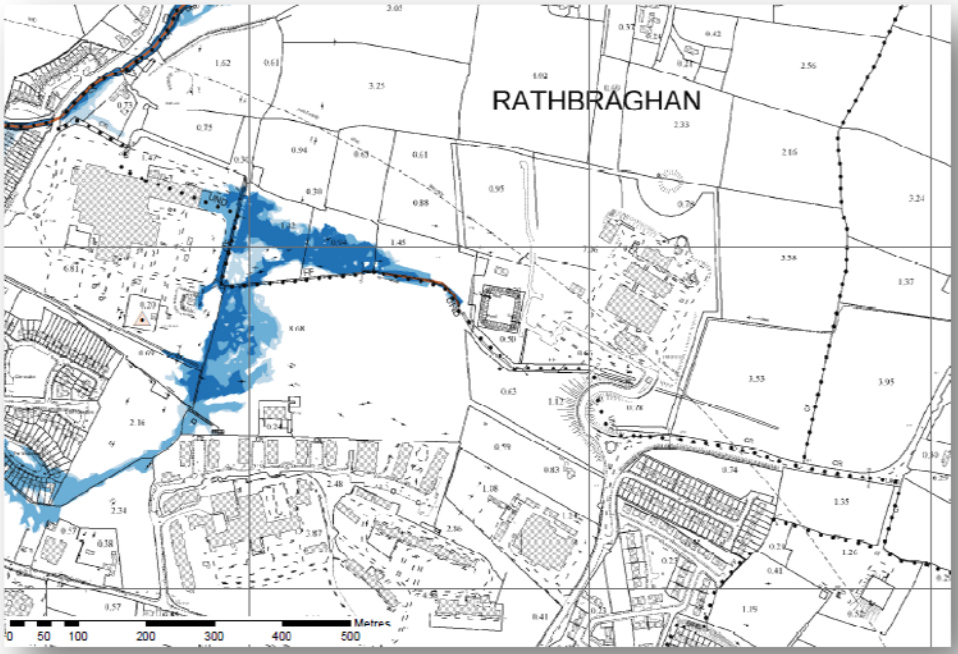
Road crossings of watercourses represent a potential impact on the flow regime and morphology of the watercourse as a result of these features requiring bridging or culverting. Given the reasonably small scale of all of the watercourses encountered by the various route options it is expected that large bridge structures will not be required by this project and that generally culverting will suffice from a flood conveyance perspective. The watercourse crossing section is generally also the location for potential road drainage discharge outfalls which can through increased flows cause local flow regime change and represents a new point source of pollution to the watercourse from the road drainage runoff resulting in local sediment deposition and water chemistry impacts including heavy metals, hydrocarbons and salt in both particulate and dissolved solute forms.

5.3.3.1.3 *Flood Risk*

Flooding along the various river systems within the study area have been assessed based on the hydrological characteristics of the catchment and by reviewing the national Preliminary Flood Risk Assessment mapping and the available draft CFRAM[1] mapping for the lower southern section of the study area near Sligo City. The various route corridors have been assessed in terms of potential encroachment within floodplain extents and generally it has been found that the proposed route options make relatively small encroachments into flood Risk Zones. Also assessed using the pFRA mapping is fluvial, pluvial, coastal and groundwater flood risk. The proposed route corridors are not impacted by coastal flood risk being on lands sufficiently elevated above the Coastal Flood Risk Zone (elevations < 5m O.D. Malin). Groundwater flooding in terms of winter turlough formation was not identified as a constraint within the route corridors with no significant groundwater flood risk or turlough formation occurring. The main source of flood risk is fluvial (river and stream flooding) and pluvial (rainfall generated overland flooding of local depressions and low-lying lands). The occurrence of pluvial flooding is very much dependent on the existing surface drainage network, the soil permeability characteristics and the topography. The southern section has a moderate number of mapped pluvial and fluvial flood risk areas, particularly at the south end of the scheme close to Sligo and along the Willsborough Stream. An extensive area of pluvial flood risk is identified in the pFRA mapping to the east of the N16 and to the north of the local road between *Bellanurly/Bellawillinbeg* and *Lisgorey* townlands. To the west of the N16 in the townlands of *Lisnalurg, Carncash* and *Rathbraghan* there are a number of small scattered pluvial flood risk areas associated with the flatter landscape and poor permeability soils. The recent final draft CFRAM mapping available for Sligo and the *Rathbraghan* area shows in more detail the flood risk zones associated with the lower Willsborough Stream and with the local Rathbraghan tributary stream that joins the Willsborough Stream just upstream of the Garvogue Estuary.

In the central and north sections of the route selection study area there are very few pluvial and no significant fluvial flood risk areas identified by the pFRA mapping. The more detailed CFRAM mapping is not available for these more rural areas. This is misleading as the high overland runoff from Cope's Mountain crossing the existing N16 towards the Drumcliff River and the Glencar Lough represents a significant flood risk to the existing road and to the proposed route options.

Figure 5-1: CFRAM Mapping - Rathbraghan



5.3.3.2 Hydrogeology

5.3.3.2.1 *Groundwater bodies and hydrogeological Features*

There are 2 groundwater bodies, the Rosses Point West GWB and the Drumcliff-Strandhill GWB, located within the study area. The Rosses Point West GWB stretches east-west from RossesPoint to *Crockauns* to the south of Glencar Lough and occupies principally the central section of the study area. This GWB is primarily underlain by Dinantian Pure bedded Limestones which are characterised as a Regionally Important karstified aquifer dominated by conduit flow. The Drumcliff-Strandhill GWB bounds the Rosses Point West GWB to the north and also to the south and occupies the northern and southern sections of the study area. This GWB occupies an area from Benbulben to Drumcliff to Sligo and Strandhill and is underlain by Dinantian Upper Impure Limestones and Dinantian shales and limestones with its groundwater aquifer characterised as locally important aquifer that is generally moderately productive only in local areas.

The main recharge mechanism to these GWB's is diffuse recharge via rainfall percolating through permeable soil and rock outcrops. The steep slopes in mountainous areas to the east of the existing N16 promote surface run-off dominated flows. In the Drumcliff-Strandhill GWB recharge is limited by Peat and the low permeability limestone bedrock and majority of recharge discharges rapidly to nearby streams and small springs. In the Rosses Point West GWB diffuse groundwater recharge occurs through the permeable soils and weathered bedrock. There is no evidence of point recharge occurring (sink holes), however there may be unrecorded karst features via which point recharge is occurring. Within the landscape of this regionally important karst aquifer there is little evidence of karst surface features and no recorded features on the GSI karst database. The main groundwater flow will be in the epikarstic layer, a couple of metres thick and in a zone of interconnected solutionally enlarged fissures and conduits that extend approximately 30 m into the bedrock and general flow direction is westward towards the coast. A small section of Dinantian sandstones

extends from Cope's Mountain towards the routes. Within the sandstones, groundwater flow is likely to be in the upper part of the aquifer similar to the limestones.

Estimated bedrock groundwater recharge rates vary depending on a number of hydrogeological factors. The main hydrogeological controls on groundwater recharge include soil and subsoil permeability, subsoil thickness, saturated soils, and the ability of the underlying aquifer to accept percolating waters. Estimated groundwater recharge is lowest in areas overlain by thick, low permeability clay. Where lower productivity aquifers underlie the land surface, recharge can be rejected, even where subsoils are thin. This reflects the limited ability of these aquifers to accept and transmit recharging waters (with maximum capacities capped at 200mm per annum). In the southern section *(Rathbraghan, Shannon Oughter, Lisnalurg* and *Bellanurly* townlands) the recharge rates are generally low reflecting the poor permeability soils and subsoils and relatively shallow water table with recharge coefficient varying from 7.5 to 25% (generally at 15%) of the annual effective rainfall (which is typically 900mm per annum). Moving northwards, the ground elevation increases and also the annual rainfall amount. Reasonably high recharge coefficients are encountered in the central section at *Castlegal* reflecting a till overlain by well drained soils of a thin cover (high to extreme vulnerability), with recharge coefficients, typically high, at 60%. The northern section of the proposed routes has a groundwater recharge coefficient of 22.5% which is moderate to low reflecting till overlain by poorly drained gley top-soil. In the northern section upgradient of the proposed routes there are sections of exposed rock outcrop and subcrop and bedrock near the ground surface giving rise to potentially very high groundwater recharge coefficient of 85% and an effective rainfall of 1150mm (975mm/annum recharge rate). This recharge rate is not achieved as the bedrock does not have the capacity to absorb such rates with a recharge capacity restricted to c. 200mm per annum.

There are no sand and gravel quaternary aquifers identified within the study area and the bedrock aquifers present are categorised as Locally Important which are moderately productive only in local zones and represent the majority of the study area except for a section of Regionally Important karstified conduit flow Limestone aquifer from *Doonally* to *Drumkilsellagh* to *Castlegal*. The aquifer vulnerability to contamination is dependent on the overburden depth and is generally categorised as moderate vulnerability (5 to 10m depths) in the southern section and increasing to high vulnerability in the central section and extreme (< 3m) in the northern section.

The main features of the groundwater flow within Glencar Bedrock Formation and within the Benbulben Shale formations both classified as Locally important Bedrock Aquifer which are moderately productive only in Local Zones, is a relatively shallow flow system within the upper weathered bedrock layer and generally the groundwater table correlates with the surface topography. The groundwater flow in the southern half of the study area is westward towards the coast, whereas in the northern half it is northwest and north with the hill slope towards the Drumcliff and Glencar Valley. The aquifer has generally a low permeability, except for local zones where there is weathering and fracturing potentially along fault lines. The major groundwater pathway is in the upper weathered zone of the rock, which may be deeper along faults and fractures. The degree of weathering depends on overburden permeability and depth of cover and purity of the limestones.

5.3.3.2.2 *Karst features*

A review of the GSI National Karst Database system shows no identified karst features within the N16 Route Selection Study Area. This karst database is not very extensive and many areas of karst features are not included in the database. Karst Features are indicated to north and east of Glencar Lough, which include a turlough and a number of springs and a number of caves and swallow hole between the R278 and the R286 to the north of Lough Gill. The bedrock formation for this area

particularly the pure limestones in the central section, but also the impure muddy formations, have a potential for karstification and the development of conduit flow preferential groundwater pathways to develop. Outcrop and sub-crop areas have been identified in the *Carncash* td area and the hillslopes near *Lugatober* and *Lugnagall*. The OSI historical mapping shows the location of a number of small springs/risings and supply wells throughout the Study area which have been mapped and defined as hydrogeological Features. A walkover visit and the OSI historical mapping reveal little evidence of significant surface karst features present within the Study area except for a local zone of karstification near *Carncash*. There are no major springs, turlough, swallow-hole or Cave features present. There are a number of small doline features evident from the aerial photography of the area which may represent possible collapse features in the *Doonally* to *Carncash* townlands. A limestone Rock outcropping is identified to the West of *Doonally* Td and some depression features are present there also.

5.3.3.2.3 *Water abstractions / groundwater supplies*

There are two main sources of water supplying the Sligo City and Environs area, namely Kilsellagh Reservoir and Lough Gill which are surface water abstractions and source protection would apply to their immediate upstream catchment. There is a water treatment plant at Kilsellagh (4500m^3 per day, recently upgraded) and two plants treating water from Lough Gill, recently upgraded Foxes Den (11,000m^3 per day) and the Cairns Hill (5,450m^3/day). The Kilsellagh Water Supply scheme serves the majority of households and agricultural connections within the N16 Route Selection Study Area and is located in reasonably close proximity to the various proposed route options, to the east and upgradient. The Kilsellagh Reservoir is supplied by mountain runoff from the southern slopes of Copes Mountain and the Eastern Slopes of Keelogyboy Mountain. The Lough Gill Public supply source is remote to the proposed route options and is located in a separate catchment and not hydrologically linked to the proposed Study area.

There are no major group water sources within the study area or any designated source protection areas located within or in proximity to the study area. The National Federation of Group Water Schemes (2015) database of group water sources identifies the following sources:

- Castletown Group scheme – Spring and Mountain Stream Source (569256, 844308);
- Benbulben Group Scheme – Spring (568278, 844497 and 568256, 844427);
- Drum East Group Scheme – Springs (570552, 843244 and 570358, 843089);
- Keelogyboy Group Scheme spring/ Mountain Stream source (577419, 838110) on the south slopes of the Keelogyboy Mountain which drain into Lough Gill;

All of these sources are not hydrologically linked to the study area and located remote from the various route options. The Castletown, Benbulben and Drum East Sources are to the North of the Drumcliff River and supplied from the slopes of the King's Mountain.

Small local household borehole supplies and wells are used to supply a number of individual or locally grouped households and agricultural supplies within the Study Area. Generally, boreholes and sunk wells were found supplying households and small springs and dug wells supplying agriculture supply connections. The more elevated northern section of the Route from Lugatober to *Gortnagrelly* is supplied by individual and grouped private wells and boreholes and not serviced by the Kilsellagh Public Supply. South of *Lugatober* mains supply is available from Kilsellagh Public water supply.

5.3.3.2.4 *Relevant Designated Sites*

The various designated sites (See section 5.3.5 for further details) in proximity to the Study area are:

- Lough Gill SAC and pNHA (001976);
- Crochauns/Keelogyboy Bogs NHA (002435);
- Sligo Leitrim Uplands SPA (004187);
- Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623);
- Cummeen Strand / Drumcliff Bay SAC and pNHA (000627) in the coastal and estuarine waters and shoreline area to the west of the Route options;
- Cummeen Strand SPA (004035);
- Drumcliff Bay SPA (004013);

The potential impact to these designated sites is limited to potential indirect impacts via watercourse discharges and groundwater flow to the Cummeen Strand and Drumcliff Bay SAC and to the Glencar Lough (part of the Ben Bulben, Gleniff and Glenade Complex SAC) and potential impact on the Bog habitat of the Crockauns/Keelogyboy Bogs NHA and the Sligo Leitrim Uplands SPA from drainage impacts.

All of the route options avoid direct encroachment but the route options are in moderately close proximity to the Crockauns/Keelogyboy Bogs NHA at *Lugnagall*. However, given the gradient and set back distance and location of proposed road cut-sections no hydrological impact Crockauns/Keelogyboy Bogs NHA is predicted.

5.3.3.2.5 *Groundwater Dependent Habitats*

A number of groundwater dependant wetland habitat sites have been identified within the study area which have the potential of being impacted by the proposed route options. The various route options pass close to these wetland sites with the potential for hydrological impact in terms of flow regime and water balance changes. A summary of these key groundwater dependant wetland habitat sites of relevance to the route selection options is presented in Table 5-1 below.

Table 5-1: Summary Description Groundwater Dependent Wetland Sites

Site no.	Site name	Annex I habitats	Ecological evaluation
10	Lugnagall Flush – south of road	Small remnants of alkaline fen and petrifying springs	National Ecological Importance as supports two Annex I habitats and overlaps with Crockauns/ Keelogboy Bogs NHA
11	Gortnagrelly – southern wet woodland	Small area of wet woodland with affinity petrifying spring vegetation	Small area of springs with no/ little tufa formation. County Ecological Importance
11	Gortnagrelly – central woodland area	Three areas of calcareous springs and significant tufa formation	National Ecological Importance as supports good examples of Annex I priority habitat within a mosaic of species-rich semi-natural woodland, river and marsh vegetation.
12	South of Collinsford	Small areas of tufa formation and vegetation with affinity to petrifying springs	County Ecological Importance as has some affinity to the Annex I priority habitat and is associated with a small area of mature wet woodland.
13	East of Drum	Rich fen and flush vegetation with some affinity to alkaline fen	Local (higher value) ecological importance as vegetation has a slight affinity to the Annex I habitat alkaline fen but is not considered to be a good example.
14	West of Castlegal	Three petrifying springs with small amount of tufa formation within semi-natural woodland	County Ecological Importance as springs are small but are examples of an Annex I priority habitat.

Site no.	Site name	Annex I habitats	Ecological evaluation
16	At the Leitrim border	No wetland Annex I habitats recorded	North-facing wooded ravine with species-rich woodland vegetation and potential to support rare/ protected bryophyte species, particularly in area of waterfalls. Part of the Ben Bulben, Gleniff and Glenade Complex SAC and therefore of International Ecological Importance.

In respect of the Lugnagall Flush wetland area immediately to the east of the existing N16 road, all of the proposed route options pass close to this feature but are located downgradient (west to northwest) of this fen feature and buffered by the existing N16 road. The topography falls northwest, with recharge to this feature from the steep hillslopes upstream sustaining this wetland habitat via interflow and groundwater flow from the upper weathered limestone and calcareous shale bedrock and subsoil interface. Recharge is reasonably high with outcropping and shallow shale and sandstone till (<3m). The steepness of the hill slopes gives rise to high overland runoff to this feature also.

The Gortnagrelly Wet Woodland with Tufa Mounds and petrifying springs which are classified as Annex 1 habit of National Significance and have a potential to be severely impacted by all of the route options. To avoid profound impacts to such features specific design measures may need to be incorporated within the road design to avoid directly encroaching the springs (bridging the discharge zone) and also ensuring that options crossing its upstream catchment do not intercept and divert groundwater recharge from its upstream catchment.

The small Wetland feature south of *Collinsford* which comprises Rich Fen and Flush vegetation is a small spring rising to a minor stream that eventually discharges into the Drumcliff River approximately 1km to the northwest. This site is considered to be of County Ecological importance with the Flush vegetation having some affinity to Annex I priority Petrifying springs habitat (7230). The potential for significant impact to this feature exists from all options both where the feature is intercepted and also where the up-gradient groundwater recharge is interfered with as a result of road construction.

The Rich Fen and Flush Feature east of *Drum* represents a small area of potential calcareous spring / alkaline fen vegetation with moderate to high potential to support Annex I priority Petrifying Spring and Annex I Alkaline Fen habitats.

The wetland feature west of *Castlegal* which is approximately 450m upgradient (east) and within the same drainage basin as the East of Drum Fen and Flush feature described in previous paragraph. This is an Alkaline Fen feature with three petrifying springs identified within the flush area which are considered to be small examples of Annex I priority Petrifying Springs habitat and is ranked as of County Ecological Importance.

The Leitrim Border ecological site is a wooded ravine and exposed limestone bedrock. No calcareous springs were recorded during the site survey. This ravine coveys a hill slope stream at a steep gradient with waterfalls features down to Glencar Lough. Given the presence of limestone outcrop and subcrop and the relatively shallow till there is a potential for calcareous springs within this feature. This feature is rated as Internationally important as it is part of the designated Ben Bulben, Gleniff and Glenade Complex SAC and pNHA (000623). .

Blanket Bog Habitat is located on upper slopes of Cope's Mountain to the east and southeast of the central and northern sections of the route options. This Blanket Bog is relatively shallow overlying shale and sandstone bedrock. These peatland habitats are located sufficiently up-gradient and

remote from the proposed route options as not to be at risk of impact from the road development and the various route options.

5.3.3.3 Fisheries

Atlantic salmon and European eel both occur within the study area. Populations of both species have declined significantly in recent years and both are protected under international law through the OSPAR convention; Atlantic salmon is also protected under Annex II and Annex V of the EU Habitats Directive. Both species are listed on the Irish Red List of Irish Amphibians, Reptiles and Freshwater Fish because of their unfavourable conservation status in Ireland.

Consultation with Inland Fisheries Ireland (IFI) also confirmed some watercourses within the study area to hold populations of sea trout and brown trout.

Several lamprey species occur in the wider area although they have not been recorded from within the study area. Sea lamprey and river lamprey are designated features of both the Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC and the Lough Gill SAC. In addition, brook lamprey also occurs within Lough Gill SAC. All three species are included within the Irish Red List of Amphibians, Reptiles and Freshwater Fish; sea lamprey occurs at very low population densities and is considered "near threatened", while the other two species are classed as "of least concern" due to apparently relatively stable populations.

Freshwater white-clawed crayfish has not been recorded within the study area but is a designated feature of Lough Gill SAC. It is listed on Annex II and Annex V of the EU Habitats Directive and categorised as Endangered by the IUCN, as well as being protected under the Wildlife Acts (1976 and 2000). Because of its habitat requirements and close proximity, it is considered possible that this species may occur within the study area and has been previously overlooked or records have not submitted to national databases.

5.3.4 **Soils and Geology**

5.3.4.1 Geological Formation

The geological formation in the study area which is outlined in Fig N16-RS-077 (contained within volume 5 of the Route Selection Report) is predominately carboniferous. Faulting is indicated to occur in transect lines between *Clooneen* and *Gortnagrelly* townlands and further south between *Tully* and *Castlegal* townlands. Geological Formations in the study area belong to the:

- *Glencar Limestone Formation:-* consisting of dark fine limestone & calcareous shale;
- *Benbulben Shale Formation:-* consisting of calcareous shale with minor calcarenite;
- *Mullaghmore Sandstone Formation:-* consisting of sandstone, siltstone & shale;
- *Ballyshannon Limestone Formation:-* consisting of pale grey calcarenite limestone;
- *Dartry Limestone Formation:-* consisting of dark fine grained cherty limestone

The recent geological history is dominated by glacial activities which has produced a classical ribbon lake, namely Glencar Valley. The valley slopes and hilly, drumlin landscape comprising the study area therefore consists primarily of glacial till overburden of variable thickness and a thin layer of topsoil. There is likely to be considerable variation in the overburden material from stiff clay with a high boulder and rock fraction to brown boulder clay with a high silt/clay content material in the latter category could pose problems if encountered in the road construction process as it may be highly susceptible to slight variations in moisture content.

Earlier this century iron pyrites was mined extensively on the southern slopes of Kings Mountain, north of Glencar Lake.

5.3.4.2 Geological Heritage

To date, sites of geological interest and heritage have not been comprehensively covered by the existing nature conservation designations. The GSI are currently drawing up of a list of sites of national geological interest that will be proposed as Natural Heritage Areas (NHAs)[42,43].

In the interim, Sligo County Council has listed in the County Development Plan (2011-2017)[44] the geological features of national and local importance with the objective of maintaining their conservation value.

County geological sites do not receive statutory protection like proposed Natural Heritage Areas (pNHAs), but receive an effective protection from their inclusion in County Development Plans. The sites described below in proximity to the N16 are considered to be of national importance, as best representative examples of particular geological formations or features. They will be proposed by the GSI for designation as pNHAs by the National Parks and Wildlife Service, after due survey and consultation with landowners.

Ben Bulben – Truskmore sites

- Ben Bulben;
- Truskmore;
- Kings Mountain Rift;
- Swiss Valley;
- Glencarbury Mine;
- Gleniff Valley;
- Diarmuid and Gráinne's Cave

It should also be noted that the Crockauns/Keelogyboy Bogs NHA (an extensive, primarily upland site incorporating large areas of blanket bog, heath, upland grassland and associated habitats) encompasses Copes Mountain and occurs in the north-east of the study area.

5.3.4.3 Made Ground, Landfill and Quarries

A number of areas of made ground have been identified from the GSI mapping within the study area. The majority of these are located within the southern half of the south section and are associated with residential, retail and industrial construction.

A site with a certificate of registration for the importation of fill has been identified within the Study Area. Sean Gilroy's Quarry, located at Lugnagall was an active quarry in the past and holds a certificate of registration to accept importation of inert fill. All of the route options in the northern section are likely to pass close to this site. This site may present a potential risk of contamination.

Two historic authorised fill sites have been identified within the study area. One of these areas is Francis Scanlon's Quarry (Glen Resources) which is no longer active. The other area is Patrick Goggins' closed landfill site located on the L3406-0 local road.

The sites of Sean Gilroy's Quarry and Francis Scanlon's Quarry were visited during the site walkover. These areas show possible areas of contaminated ground from disused construction machinery plus waste material noted at the ground surface.

[42] Environmental Protection Agency (2007) *Development of a methodology for the characterisation of a karstic groundwater body with particular emphasis on the linkage with associated ecosystems such as turlough ecosystems (2002-W-DS-8-M1).*

[43] National Parks & Wildlife Service www.npws.ie.

[44] Sligo County Council www.sligococo.ie.

5.3.4.4 Soft Ground

A limited area of blanket peat is noted at the far northern end of the Study Area.

Two limited areas of alluvial deposits were recorded in the central section adjacent to an existing stream in the townlands of Drum East and Drumkilsellagh. This material is recorded as alluvium – gravelly on the Teagasc soils database and may not present any problems for road construction if material is found to be granular.

An area of estuarine sediments was recorded on the GSI subsoils mapping to the west of the existing N15 between Sligo Town and Shannon Eighter in the Southern Section. This material is located adjacent to Sligo Harbour where a number of rivers including the Garvogue River and Willsborough Stream enter Sligo Harbour.

A number of areas of alluvium were recorded in the southern section adjacent to a number of streams including the Willsborough Stream and its tributaries.

All this material which is recorded as '*alluvium – gravelly'* on the Teagasc soils database and may not present any problems for road construction if material is founded to be granular. Alternatively cohesive alluvial material is likely to be soft, highly compressible and would present problems for road construction.

5.3.5 **Designated Sites & Protected Areas**

A number of sites each which host an important assemblage of Flora and Fauna occur within or in proximity to the Study Area (See Fig N16-RS-074/075/076 in Volume 5). These sites are designated for protection at a European/National level.

At European level, Natura 2000 sites form a network of protected areas throughout the European Union. They comprise Special Areas of Conservation (SACs) designated under the EU Habitats Directive, and Special Protection Areas (SPAs) designated under the EU Birds Directive. The Habitats and Birds Directives were transposed into Irish law through the Natural Habitats Regulations (1997).

Proponents undertaking any plan or project that is likely to have a significant impact on a Natura 2000 site are required to undertake a Habitats Directive Assessment (HDA). At national level, the Wildlife Act 1976 and the Wildlife (Amendment) Act 2000 are the principal statutory provisions for the protection of wildlife (both flora and fauna) and the control of activities which may impact adversely on the conservation of wildlife.

Under the Wildlife (Amendment) Act 2000, Natural Heritage Areas (NHAs) are designated to conserve species and habitats of national importance.

In addition, there is a range of plants and animals and their associated habitats that are protected under European and national legislation, wherever they occur.

5.3.5.1 European Designated Areas (Natura 2000 sites)

Five Natura 2000 sites lie within or immediately adjacent to the study area:

5.3.5.1.1 *Benbulben, Gleniff and Glenade Special Area of Conservation (SAC).*

This area includes upland habitat over limestone and shale's, situated at the extreme eastern end of the study area. A small section of this SAC lies within the study area, to the north of the current N16. This SAC is of particular importance for alpine plants, some of which occur nowhere else in Ireland, but it is also of importance for otter, peregrine and Geyer's whorl snail.

5.3.5.1.2 *The Sligo / Leitrim Uplands Special Protection Area (SPA).*

This area of limestone cliffs, upland habitats and scree borders the south west of the study area. It is designated because of its importance for breeding peregrine and chough, but also supports a rich assemblage of arctic-alpine vascular plants and bryophytes.

5.3.5.1.3 *Lough Gill Special Area of Conservation (SAC).*

This lies to the immediate south of the study area, and comprises the eutrophic lake Lough Gill and its associated woodland and wetland habitats, as well as otter, Atlantic salmon, lamprey species and white-clawed crayfish.

5.3.5.1.4 *Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC.*

Located immediately west of the study area, this incorporates estuarine and dune habitats and tufa springs, with associated species such as seal and lampreys.

5.3.5.1.5 *Cummeen Strand Special Protection Area (SPA).*

Immediately west of the study area and occupying part of the same area as Cummeen Strand / Drumcliff Bay (Sligo Bay) SAC, the site is designated because of its importance for wintering waterfowl.

5.3.5.1.6 *Drumcliff Bay Special Protection Area (SPA).*

This site lies approximately 2.5km outside the study area, at the mouth of the Drumcliff River, which provides biological connectivity between them. Drumcliff Bay SPA lies within the zone of influence of any future works which may be carried out within the study area. It is designated on the basis of its importance for wintering waterfowl, supporting nationally-important populations of sanderling and bar-tailed godwit.

5.3.5.2 Nationally Designated Areas

One designated Natural Heritage Area (NHA) and three proposed Natural Heritage Areas (pNHA) lie partially within, or immediately adjacent to, the study area:

- Crockauns / Keelogyboy Bogs NHA;
- Cummeen Strand/Drumcliff Bay (Sligo Bay) pNHA;
- Lough Gill pNHA;
- Benbulben, Gleniff and Glenade Complex pNHA.

A fifth proposed Natural Heritage Area, Colgagh Lough pNHA, lies just over 2km from the study area but is unlikely to fall within its zone of influence, as the areas are not connectedby features of drainage or topography.

Further information relating to Natura 2000 and NHA sites is included within the Ecology Report carried out as part of the Constraints Study and included Volume 3, Part B, of the Route Selection Report.

5.3.6 **Nature Reserves & National Parks**

5.3.6.1 Nature Reserves

A Nature Reserve is an area of importance to wildlife, which is protected under Ministerial order. Most are owned by the State. However, some are owned by

organisations or private landowners, and persons interested in acquiring statutory protection for their lands can seek advice on this matter from the Department.[45]

There are no Nature Reserves located in the proximity of the Study Area.

5.3.6.2 National Parks

In 1969, the International Union for the Conservation of Nature (IUCN) recommended that all governments agree to reserve the term 'National Park' to areas sharing the following characteristics:

- *Where one or several ecosystems are not materially altered by human exploitation and occupation; where plant and animal species, geomorphological sites and habitats are of special scientific, educational and recreational interest or which contain a natural landscape of great beauty;*
- *Where the highest competent authority of the country has taken steps to prevent or eliminate as soon as possible exploitation or occupation in the whole area and to enforce effectively the respect of ecological, geomorphological or aesthetic features which have led to its establishment;*
- *Where visitors are allowed to enter, under special conditions, for inspirational, educational, cultural and recreational purposes.*

It is the policy of the Department of Arts, Heritage and the Gaeltacht, endorsed by successive governments, to abide by the criteria and standards for National Parks as set by the IUCN.[45]

There are no National Parks located in the proximity of the Study Area.

5.3.6.3 County Development Plan – Natural Heritage

At a County scale the County Development Plan (CDP) for Sligo (2011 – 2017), protects additional Natural Heritage sites through its core aims, policies and objectives. General Policies under Natural Heritage in this regard including *inter-alia* to*:*

Protect, sustainably manage and enhance the natural heritage, biodiversity, geological heritage, landscape and environment of County Sligo in recognition of its importance for nature conservation and biodiversity, and as a non-renewable resource, in association with all stakeholders.

...Ensure as far as possible that development does not impact adversely on wildlife habitats and species. In the interest of sustainability, biodiversity should be conserved for the benefits of future generations.

In general Flora and Fauna interests not covered in section 5.3.5.1 and 5.3.5.2, are dealt with in the Flora, Fauna & Fisheries section of Volume 3, Part B. Sites of Geological Interest are covered in section 5.3.4 of this Report.

[45] www.npws.ie

Figure 5-2: Image extracted from 'Natural Heritage' section of Sligo County Development Plan

5.3.7 Woodland (Naturally occurring broadleaf and commercial)

The Flora, Fauna & Fisheries Report contained within Volume 3, Part B of the Route Selection Report identified two main woodland areas in the north-eastern part of the site, in the townlands of *Lugatober* and *Lugnagall*, where the existing N16 extends along the foot of Cope's Mountain.

The area comprises part of the Crockauns / Keelogyboy Bogs NHA, the site synopsis for which states that woodland in the area supports Irish Whitebeam. This woodland is considered to be an important constraint in ecological terms.

The woodland in the townland of *Lugatober* appears to be largely comprised of ash, and is periodically grazed by sheep. A number of the streams in the north-eastern part of the study area are bordered by wooded areas or scrub. Most notably, the two easternmost streams are bordered by a mix of native species, in particular to the north of the existing N16. Although these areas are generally grazed and have little in the way of under storey vegetation, they are likely to be of value for other species, such as feeding bats and breeding birds. In addition, there is significant growth of bryophytes in places.

The south-western part of the study area is mainly pasture interspersed with dwellings, but contains two main areas of woodland. One is associated with the Doonally / Rathbraghan stream, mainly west of the existing N16, with a small section to the east. This area is a linear woodland, extending for over 1 km along the stream, and appears to be variously dominated by beech, alder and ash. It has a relatively open structure in the vicinity of the existing N16 but scrub species appear to increase westwards. The other area of woodland in this section of the study area is situated slightly further north, associated with the Willowbrook tributary of the Rathbraghan stream, where it flows westwards from the Kilsellagh reservoir and then southwest adjacent to the existing N16.

Other than this, there is little woodland in this section of the study area but it does support a well-established network of hedgerows, containing substantial numbers of trees in places, some quite mature. These are particularly abundant in the *Drum* area.

5.4 Artificial Constraints

5.4.1 Introduction

The following section provides a description of the artificial constraints occurring within the study area which are those that form part of the built environment.

5.4.2 Existing Road Network

In a general sense, the N16, N4 and N15 national primary road corridors, provide a strategic means of access both into and through Sligo City. The main regional roads in the study area which support the national network include the R278 and R286 to Manorhamilton and Dromahair respectively.

There is a vast network of local roads in the study area serving the local population, these generally include; connections to Sligo City, cross country routes between the national network and connections to the general areas of *Glencar, Kilsellagh* and *Calry*.

5.4.3 Traffic

A broad overview of existing traffic volumes and trip attractions has already been provided in section 3.5.1 of this Route Selection Report. Further information in relation to traffic model information is provided within sections 8, 9.3.1, 10.3.1 and 11.3.2 of this Main Report.

5.4.4 Other Transport Modes

With the exception of scenic walking and cycling routes on the local road network, there is no alternative existing transport mode for the N16 National Primary Route.

5.4.5 Houses

The N16 itself has considerable housing development along its entire length but particularly at *Bellanode, Barroe, Doonally, Drumkilsellagh, Castlegal, Lugatober* and *Gortnagrelly*.

Domestic ribbon development is also spread along most of the county roads within the study area between the N16 and N15 to the west. This is most prevalent in the following locations:

- All local roads south of (and including) the Drum Road (L-3406-0);
- Sections of the L-7403-0 at *Lugatober*;
- Sections of the L-7404-0 at *Lugnagall*;
- Sections of the L-7411-0 at *Gortnagrelly*;

The N15 also has a number of houses directly accessing the national primary network between *Shannon Eighter* and *Teesan* townlands. All areas within the City Environs, south of *Rathbraghan* are heavily developed with housing estates at *Yeats Heights, Rathbraghan, Ballytivnan* and *Bellanode*.

5.4.6 Other Buildings and Structures

Some of the more significant commercial, industrial, educational and public sector industries in the vicinity of the N16 include the following.

5.4.6.1 AbbVie

AbbVie Ireland operates two separate plants in Sligo employing more than 200 staff. The company's high containment facility on the Manorhamilton Road (N16) was established in 2002 and has

dedicated capabilities for potent active pharmaceutical ingredient and drug product manufacturing. This facility recently underwent a significant €85 million expansion that doubled its footprint, providing additional capability to support AbbVie's new product introductions.

5.4.6.2 Abbott Ireland – (Ireland Nutrition Division - Sligo)

Established in 1974 and situated in *Ballytivnan*, Sligo. Abbott manufactures feeding devices for patients with special dietary needs due to injury or illness.

Abbott (Ballytivnan) are currently a tenant of AbbVie.

5.4.6.3 Institute of Technology Sligo (IT Sligo)

IT Sligo is a Third level educational institution founded in 1970 and located on Ash Lane, Sligo. The IT hosts a student population of approximately 6,000 with 550 employed staff. IT Sligo is situated on a 70 acre campus with sports facilities including a multipurpose arena, outdoor athletics track and floodlit soccer/Gaelic pitches.

5.4.6.4 Regional Veterinary Laboratory

The Department of Agriculture's Regional Veterinary Laboratory is located adjacent to the N16 at Fawcett's Bridge, *Doonally*. The facility provides a laboratory diagnostic service to private veterinary practitioners and farmers.

5.4.6.5 MSLETB Training Centre Sligo

Mayo, Sligo and Leitrim Education and Training Board (MSLETB) training centre is located on the N16 at *Ballytivnan*, Sligo. It is a training based centre offering day courses, evening courses and skill based apprenticeships.

5.4.6.6 Clayton Hotel Sligo

Situated on the Clarion Road, Sligo; the Clayton is a four star hotel with leisure and conference facilities. The hotel holds 74 bedrooms and 89 suites.

5.4.6.7 Sligo Tennis and Badminton Club

Established in 1984 and located on the Old Bundoran Road, Sligo. This club hosts 6 outdoor flood lit tennis courts, 1 indoor tennis court, 5 badminton courts and 4 squash courts.

5.4.6.8 Sligo Nursing Home

Located in *Ballytivnan*, Sligo; this is a private nursing home with 62 beds.

5.4.6.9 St. John's Community Hospital

Located on the Ballytivnan Road, *Ballytivnan*, Sligo; this Community Hospital provides a Rehabilitation Unit and four extended care units, a day hospital, a Physiotherapy Department and an Occupational Therapy Department. Established since 1971 this unit can accommodate up to 115 residents providing long term care.

5.4.6.10 Alzheimer's Day Care Centre Doonally

Located in Faughts Lane, Co. Sligo; this centre provides support and services for people with dementia. The centre is open from Mondays – Thursdays.

5.4.6.11 HSE Mental Health Inpatient Services

Formerly St. Columba's Hospital, this inpatient service is located in *Ballytivnan*, Sligo.

5.4.6.12 National Schools

There are a number of National Schools located within or proximate to the study area, these include:

- Rathcormack national School, located in *Rathcormack* hosts 239 students (2014/2015);
- Saint Edward's National School, located on the Clarion Road, hosts 191 students (2014/2015);
- St. Josephs National School, located in *Ballytivnan* is designated for pupils who have been assessed as having a Mild General Learning Disability. It caters for pupils between the ages of 5 and 18 years.
- Carbury National School is located in the grounds of Sligo Grammar School and caters for over 200 students;

5.4.6.13 Secondary Schools

There are a number of Secondary Schools located within or proximate to the study area, these include:

- Bellanode College in *Bellanode*, Co. Sligo. It caters for 675 students (2014/2015);
- Sligo Grammar School is located opposite Sligo General Hospital on the R286. It caters for approximately 450 students;

5.4.6.14 Religious Facilities

There is only one religious facility within the study area. Saint Joseph's Roman Catholic Church is located on the Ballytivnan Road, *Ballytivnan*, Sligo.

5.4.6.15 Other

Other buildings occurring within the study area include:-

- Multi Purpose Sports Pitch in *Ballytivnan*;
- Feehily's Funeral Home (N16);
- Esso (N16);
- Texaco/Spar (N15);
- Supermac's (N15);
- Horkan's Garden Centre (N15);
- Henderson Motorpark (N15);

5.4.7 **Planning Control**

5.4.7.1 County Development Plan

The County Development Plan has been reviewed in order to identify policies and objectives that may impact on land use and development within the study area. In terms of planning control policy, the CDP states that the Local Authority shall:

Plan for the future traffic and transportation needs in Sligo and ensure that new development does not compromise the expansion of rail and road corridors in the County. Proposed road realignment/improvement lines and associated corridors shall be preserved free from development that would prejudice the implementation of the road scheme.

5.4.7.2 Sligo & Environs Development Plan

The Sligo and Environs Development Plan (SEDP) and its Local Area Plan (North Fringe Plan) cater for the long term expansion of Sligo, e.g. identifying long term needs over a 10-20 year period.

The SEDP has considered a number of development scenarios and adopts a 'compact city' approach, based upon achieving a balance between the consolidation/regeneration of the existing built-up area and the planned expansion of the City into the Environs. This approach has been determined to have the least extent of potential environmental effects.

The North Fringe area is a key element of this adopted development scenario, providing a substantial proportion of the expansion capacity for Sligo into the long term.

5.4.7.3 Protected Buildings

It is the objective of the County Development Plan to:

...seek the protection and conservation of buildings and structures of architectural, historical, archaeological, artistic, cultural, scientific, social and technical importance.
The principal mechanism for protection of these buildings and structures is through their inclusion on the Record of Protected Structures (RPS). This provides positive recognition of the structures' importance, protection from adverse impacts and potential access to grant aid for conservation works.
The Planning and Development Act, 2000 (Part II, Section 10(2)(f) and (g)) places a statutory obligation on local authorities to include in their development plans objectives for the protection of structures, or parts of structures, which are of special architectural, historic, archaeological, artistic, cultural, scientific, social or technical interest. These buildings and structures are listed in a register known as the Record of Protected Structures (RPS).

There are currently 400 structures included in the Record of Protected Structures for County Sligo. As the review of the Record of Protected Structures is an ongoing process, these figures may change during the lifetime of this Plan. The Record of Protected Structures 2010-2016 lists 299 structures located in the Sligo and Environs area.

5.4.7.4 Planning Applications

The Planning Department of Sligo County Council operates and maintains a Geographical Information System (GIS) database of all planning applications within the County. This information has been collected for the current study area and is included within Volume 5 as Figures N16-RS-065, 066 and 067. The information stored includes the application number, details of the type of development proposed (i.e. domestic or commercial), the date of application and the status of the same (i.e. if granted or refused).

5.4.7.5 Land Ownership

The Property Registration Authority of Ireland (PRAI) has provided the Local Authority with digital spatial and textual information of all properties registered within the Constraints Study area.

The information provided, includes boundary information of the registered properties together with the following Folio attributes:

- Folio;
- Property Number;
- Plan Number;
- Owner Name(s);
- Application Number - Lists applications pending (if any) against Folios;
- Address - This is the address for service of notices in the state;
- Seed point X and Y ITM coordinates of each Folio boundary

Land ownership mapping, current in January, 2016, is included in Figures N16-RS-071, 072 and 073 within Volume 5.

5.4.8 Archaeology, Architecture & Cultural Heritage

5.4.8.1 Constraints Study

An initial Constraints Study assessment was carried out by Irish Archaeological Consultancy Ltd. in advance of the development of Feasible Route Options. In summary, and in terms of constraints (See Figures N16-RS-082 to 087 within Volume 5), it was assessed at the constraints stage that there were a total of 45 Sites and Monuments Record (SMR)/Record of Monuments and Places (RMP) sites within the Constraints Area. A substantial number of these sites can be ascribed to the early medieval period, with ringforts and enclosures being most frequent. Additionally, there are a number of Areas of Archaeological Potential (AAP) with the area including Glencar Lough, various streams and smaller rivers, lakes, coastal margins and areas of bog/peat land.

In terms of Architectural & Cultural Heritage; there are a total of 7 individual or groups of protected structures and National Inventory of Architectural Heritage which should be considered as Cultural Heritage Constraints (CHC) sites. Additionally there are 10 designed landscapes (based on current information). Also identified are post medieval buildings and sites of Archaeological Potential which are also considered to be Cultural Heritage Constraints.

A more detailed Preliminary Options Assessment, was carried out by ACSU, which comprised two separate studies covering the disciplines of Archaeology and Cultural Heritage and Architectural Heritage. This allowed for further information in relation to Constraints to be gathered as outlined in sections 5.4.8.2 and 5.4.8.3.

5.4.8.2 Archaeology and Cultural Heritage, Preliminary Options Assessment

The area is well represented in the archaeological record for most of the main periods of Irish history and prehistory.

The Bronze Age is represented by a small number of burnt stone mounds, a wedge tomb, and enclosures that may represent ring ditches or barrows. Widespread Early Christian settlement is indicated by the presence of ringforts, and enclosure sites. Some of these enclosures may be remnants of destroyed ringforts or other archaeological site types. More recent times have witnessed the building of country houses and industrial buildings, some of which have been included in the National Inventory of Architectural Heritage Interim Survey prepared by the Department of the Environment, Heritage and Local Government and may soon be adopted by the County Council as Protected Structures.

There were in total 79, known or archaeological and cultural heritage sites of potential, identified during the Preliminary Options Assessment. A few of the items listed are sites and structures of

potential rather than of known interest and were identified from an examination of historical mapping. No crop or soil marks on aerial photography were found that may have indicated the presence of archaeological sites whose above ground remains may be largely or completely destroyed. A few of the sites listed are potential architectural heritage buildings, or clusters of buildings including houses, mills and bridges.

There are a number of watercourses in the study area. In addition to watercourses, areas of archaeological potential also include wetlands, gravel ridges, areas of bogland or marsh and hills with commanding prospects and sheltered slopes. Such areas have been found to be of archaeological potential because they were either utilised by people in the past for settlement or for economic purposes or because, by their nature, they preserve subsurface archaeological remains, features or deposits. This is particularly the case with wetlands where anaerobic conditions preserve structures or items made from organic materials such as wood or fibre which would normally decompose.

5.4.8.3 Architectural Heritage, Preliminary Options Assessment

The majority of the proposed route options travel through a rural landscape that in the 18th century consisted of mainly single and small groups of rural vernacular dwellings and their associated outbuildings and garden plots. Alongside these rural vernacular dwellings there are a small number of larger farms, which over time developed into larger farm complexes with associated farm buildings; these include a small number of estates and their associated demesnes with landscaped grounds. The development of the landscape within the 18th and 19th centuries also saw the development of the road network and its associated structures such as bridges. The landscape has also witnessed the development of industrial buildings in the 18th century. Over time many rural vernacular dwellings of 18th century date have been abandoned or replaced/converted into modern dwellings and modern housing estates and industrial buildings have been developed in the hinterland north of Sligo City.

In total, there were 39 sites of known, or of potential architectural heritage value identified as part of the Preliminary Options Assessment study. A few of the items listed are sites and structures of potential rather than of known interest and were identified from an examination of historical mapping and include houses, mills and bridges.

5.4.9 **Population, Economy, Tourism, Amenities & Business**

5.4.9.1 Population

The main population within the study area is the city of Sligo to the south, with a population of approximately 17,400 in 2016, this constitutes is the largest urban centre in the North-West and the second largest in the west. *Given its location midway between Galway and Derry (circa 140 km from each city), Sligo is the natural capital of a substantial territory in the North-West*[46].

5.4.9.2 Economy

Along with its development potential in terms of existing infrastructure and services, Sligo's strategic location was a critical element in its designation as a Gateway under the National Spatial Strategy.

The city's spatial position means that it is capable of energising a wider area encompassing parts of Mayo, Donegal and Leitrim, as well as capitalising on cross-border co-operation initiatives, while

[46] Sligo and Environs Development Plan, 2011 to 2016

being at the northern end of an emerging extended Atlantic Gateways corridor (currently comprising only Waterford, Cork, Limerick and Galway)[46].

The rural area of the Constraints Area is sparsely populated although ribbon development is common along both the National and Local road network.

5.4.9.3 Tourism

The N16 climbs alongside the western slopes of Cope's Mountain and provides views across to the coast, King's Mountain and Glencar Lough. Cope's Mountain is not generally accessible to the public, but river valleys descending from the mountain across the study area are valued locally for their wildlife and wooded settings. Glencar is an important tourist destination (circa 80,000[47] visitors per annum) that includes views of and access to waterfalls and the King's Mountain plateau. Pictures of the area regularly feature in promotional literature for the county and the area is well visited by local people and tourists, both domestic and international, for casual visits, cycling and walking. A lay-by at *Gortnagrelly* provides views across to Glencar and King's Mountain. Consequently, the landscape, and the minimisation of visual impacts is an important consideration in the route selection process.

5.4.9.4 Amenities & Business

5.4.9.4.1 *Wider Study Area*

The wider study area which includes sections of Sligo City has a rich abundance of amenities in its vicinity. A non-exhaustive list includes the following:

- Glencar Waterfalls and amenity areas;
- Numerous freshwater and sea water angling activities;
- Seaside resorts at Rosses Point and Strandhill;
- Sports facilities including numerous Gyms, Swimming Pools, GAA, Soccer, Rugby, Hockey, etc.;
- Horse Racing at Cleveragh;
- Outdoor activity centres including new Sligo County Council facilities at Doorly Park;
- Numerous Heritage & Visitor centres;
- Other amenities typical of an urban/tourist destination such as cinema, a rich abundance of hotels and restaurants, play centres etc. ;

Also occurring directly within the Study area is the North West Cycle Trail which is a 326km circular route through counties Donegal, Tyrone, Fermanagh, Leitrim and Sligo. The route for the most part travels along local roads in rural areas with traffic free sections located in urban areas were possible. This route intersects through the study area along the following roads from South to North in clockwise format; from the R286-2 the trail continues left onto the N16 (Ash Lane), the trail then turns right at the roundabout with the N16 (Duck Street) onto the L-9005-0 and continues onto the L-7422-0 and L-7421-0.

[47] http://failteireland.ie

5.4.9.4.2 *Community Facilities*

Community facilities in the north and central sections of the study area include an Alzheimer's daycare facility at *Doonally* and the Sligo Tennis Club in the vicinity of Shannon Oughter. As well as private dairy, cattle and sheep farms, several other types of business are located along the N16 including B&Bs at *Lugatober* and *Farnacardy*, a shot blasting business, a haulage business and the Regional Veterinary Laboratory. Calry National School (St. Patrick's) is located to the east of the study area, but as noted above is accessed by traffic from across the study area.

A high concentration of community facilities and businesses are found in the southern section. These, together with residential development and the identifiable communities of *Ballytivnan* and *Rathbraghan*, restrict the space available for route options. On the northern boundary of this section is the Clayton Hotel which is contained within the impressive façade of the former St. Columba's Hospital and occupies extensive grounds. This section also includes Sligo IT and student residences, Ballinode Community College, Sligo College of Further Education, and HSE Mental Health Inpatient Facilities, Resource and Training Centres. On the edge of *Ballytivnan* are St. Edwards National School, St. Joseph's Special School and St. Joseph's Parish Church. The suburb also includes a nursing home, a community centre and a small park area including a basketball court. The AbbVie international pharmaceutical company occupies two sites, one off the N16 and another just north of Ballytivnan. Sligo General Hospital and Sligo Grammar School are located south of the N16 Ash Lane, the former with an entrance off this road. A Traveller halting site is also located here.

5.4.10 Air Quality & Climate

5.4.10.1 National Ambient Air Quality Monitoring Network

The Environmental Protection Agency manages the national ambient air quality monitoring network. They also measure the levels of a number of atmospheric pollutants. The pollutants of most concern are those whose main source is traffic such as Particulate Matter and Nitrogen Dioxide. Air Quality in the Study Area is described by the EPA as being 'Good'.

5.4.11 Utilities

5.4.11.1 ESB

The study area is supplied by a network of overhead 10kv lines which by enlarge run in open fields and not within existing road network landtake width. A number of low voltage overhead lines also exist and the main Ballytivnan to Bundoran 38kv grid line runs northwards from *Ballytivnan* to *Cloonderry* through open fields.

The study area is crossed by an ESB network transmission of high voltage 38kV overhead lines and high voltage 38kV underground lines. The main 38kV high voltage lines runs from a substation located in *Cranmore* to *Ballytivnan* and on to *Aghagad* with a spur joining to Hazelwood (all located with county Sligo). There is one substation located within the study area at Ballytivnan.

The study area is supplied by an ESB network distribution of medium and low voltage overhead lines. More details of these electricity supply cables can be seen in Figure N16-RS-068 to 070.

5.4.11.2 Telecommunications

The sporadic housing development within the study area means that the overhead telephone line network is extensive. The network tends to follow the road network with poles often situated in road verges. A major network follows the N16 from the City Boundary to the County Boundary with

Leitrim. From Sligo City the main telecommunication cable linking Sligo with Donegal etc. is situated adjacent to the N15.

5.4.11.3 Broadband

BT Network have a network line located within the study area and can be seen in Figure N16-RS-068.

E-Net has fibre optic cables located within the study area serving all major residential and industrial areas. More information on this network can be found in Figure N16-RS-068.

5.4.11.4 Gas

Gas Networks Ireland confirmed that there is no distribution or transmission gas pipelines/infrastructure located within the study area.

5.4.11.5 Water and Wastewater

Water abstractions and supplies have already been described within section 5.3.3.2.3 of this Main Report.

In terms of wastewater, the urban fringes of the Study area occurring to the south discharge to the Sligo Main Drainage Wastewater Treatment Works. The Works provides extensive treatment in the form of primary settlement, biological secondary treatment, final settlement and final recycled water UV disinfection.

The rural sections of the study area, located to the north of Sligo, are generally treated via domestic septic tank and proprietary waste water treatment works.

5.4.12 Noise & Vibration

The specific objective of the noise input to the Constraints Study is to identify any receptors that may be deemed to be particularly sensitive to noise and/or vibration.

The NRA Guidelines for the Treatment of Noise consider the following examples as being Noise and Vibration sensitive receptors:

> *...schools, hospitals, places of worship, heritage buildings, special habitats, amenity areas in common use and designated quiet areas. However, residential properties must not be overlooked, and it may be noted that some commercial or industrial uses can also be noise sensitive, for example, recording studios and research or manufacturing facilities using noise or vibration-sensitive equipment.*[48]

The Constraints Study phase included a desktop examination of sensitive receptors; these include *inter-alia*:

- The domestic houses as already outlined in section 5.4.5;
- Institute of Technology Sligo (IT Sligo);
- MSLETB Training Centre Sligo;
- Rathcormac national School;
- Saint Edward's National School, located on the Clarion Road;
- St. Josephs National School, located in Ballytivnan;
- Carbury National School is located in the grounds of Sligo Grammar School and caters for over 200 students;

[48] Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes

- Sligo Nursing Home;
- St. John's Community Hospital;
- HSE Mental Health Inpatient Services

5.4.13 Agriculture

The CORINE (Coordinated Information on the Environment), classes the rural section of the study area to be generally pasture land. Various agricultural buildings occur throughout the study area; chiefly storage barns and hayshed's, however milking parlours also occur in isolated areas.

According to the *Census of Agriculture 2010*, there were 4,395 active farms in Co. Sligo in June 2010. The average farm size in Co. Sligo was 26.3 hectares which is significantly lower than the national average of 32.7 hectares for 2010.

Table 5-2 presents the number of farms in each Electoral District (ED) which are within (or partially within) the study area and the number of Agricultural Area Utilised (AAU) hectares farmed in each ED. The AAU is the combined area under crops, silage, hay, pasture and rough grazing land in use (including fallow land). Areas under roads, tracks, water, bog, marsh, rocks, unused rough grazing land, buildings, etc. are excluded.[49]

Table 5-2: Number of Farms by Electoral District (ED) and Area Farmed[50]

Electoral District (ED)	Total No. Of Farms	Area Farmed (Hectares)
Glencar	28	811
Drumcliff East	40	1,070
Calry	98	2,027
Sligo North	2	*
Total	168	3,908*

5.4.14 Land-Use

The principal study area, i.e. the Southern Section of the route corridor, consists of urban, suburban and peri-urban/rural elements, to the north of Sligo City Centre.

The southern/urban part of the area contains or adjoins substantial urban development of a commercial and residential nature and a number of locally strategic facilities, including Sligo University Hospital and Sligo Institute of Technology. Additional uses such as schools, nursing homes, health centres, recreational facilities etc. are also located in the area.

North of the Sligo Institute of Technology and nearby residential uses is a substantial land bank identified for business, industry and technology uses and currently contains two AbbVie Plants, one of which (Ballytivnan) currently also accommodate Abbott Ireland – (Ireland Nutrition Division - Sligo).

[49] Census of Agriculture 2010

[50] Information as to area farmed is not available from the *Census of Agriculture 2010* for reasons of confidentially. Therefore, total area farmed is greater than value stated in table.

The future expansion of this land bank for business, industry and technology uses whether by expansion of existing facilities or the introduction of additional industries will be key to the long term development of Sligo.

North of the business, industry and technology land bank, the study area is largely rural / peri-urban, with established residential use to the west. Outside the main existing built up area, there are dispersed rural dwellings and ribbon development, and limited commercial development along a number of local roads and along the N15 and N16 routes.

Much of the land north of the existing built up area is in agricultural type use, however has been zoned for longer term expansion of the City for varying uses necessary to achieve the growth targets and appropriate distribution of land uses for the city.

5.4.15 Burial Grounds

There are no burial grounds within the Study Area.

5.5 Public Consultation No. 01: Constraints Study

5.5.1 Public Consultation No. 01 – Constraints Study Area

In order to initiate the participation of the public at the earliest possible opportunity; a Public Consultation process in relation to the Constraint's Study's Phase was conducted between the 29th of July and the 14th of August, 2015. This process included two information days held in the Clarion Hotel (Sligo) on the 29th and 30th of July, 2015.

This process encouraged feedback from the general public in relation to aspects of the project. In this regard a predefined questionnaire was completed by 31 respondents prior to the closing date for submissions; the following are the main findings of same:

- 84% of people who responded to questions own 'Residential' or 'Residential & Farm Property';
- 100% of respondents agreed that an improvement of the N16 is required;
- The most important reasons for improvement of the N16 would appear (from respondents opinions) to relate to (1) safety, (2) current access arrangements, and (3) improved journey times as outlined in Table 5-3;
- In terms of selecting an optimal route location for the N16 (from respondents opinions); the most important factors were considered to relate primarily to minimising impacts on existing properties followed by minimising impacts on landscape as outlined in Table 5-4.

Table 5-3: Public Opinion – What are the most important reasons to be considered for improving the N16

What are the most important reasons for Improving the N16?	Answer Weighting (1 = Highest Importance/5 Least Importance)				
	1	2	3	4	5
To relieve traffic congestion and general driving conditions on the route.	9.68%	16.13%	51.61%	22.58%	0%
To improve accessibility both onto and off the existing route.	16.13%	35.48%	22.58%	25.81%	0%

What are the most important reasons for Improving the N16?	Answer Weighting (1 = Highest Importance/5 Least Importance)				
	1	2	3	4	5
To improve Safety.	61.29%	22.58%	6.45%	6.45%	3.23%
To improve journey times from Sligo to the north of Ireland – thereby improving north/south connectivity.	6.45%	25.81%	9.68%	45.16%	12.5%
Other.	6.45%	0%	9.68%	0%	83.87%

Table 5-4: Public Opinion – In establishing the optimal route location; how important do you feel the following factors are?

Factor Considered	Importance		
	Very Important	Important	Least Important
To minimise impacts on Landscape	41.94%	51.61%	6.45%
To minimise impacts on Agriculture	32.26%	45.16%	22.58%
To minimise impacts on existing Properties	58.06%	29.03%	12.5%
To minimise impacts on Flora & Fauna	22.58%	58.06%	19.35%
To minimise impacts on Archaeology & Cultural Heritage	35.48%	58.06%	6.45%
To minimise impacts on Commercial & Industrial Activities	12.50%	58.06%	29.03%
To minimise impacts on Amenity Areas	35.48%	61.29%	3.23%
To minimise impacts on Community Severance	35.48%	58.06%	6.45%

As part of the questionnaire, the public were given the opportunity to express their main concerns in relation to the route. In this regard the following is a non-exhaustive outline of some comments which are general to the route selection/improvement as opposed to specific to certain localised issues:

"...The existing N16 is extremely dangerous and particularly accident prone during the winter months with snow, ice and fallen trees. In the course of my work and that of 15 others and members of the public attending the regional veterinary lab at Fawcett's Bridge, we/they are exposed to significant traffic hazards entering and exiting the laboratory and again at the Faecett's Bridge intersection. We realise that this is a long term plan, however we feel that intermediate plans should be drawn up to MITIGATE THE 'RISKS' between a point 200 yards east of the laboratory and 200 yards on the town side of Fawcett's Bridge. (Submitted are signatures who are the view that this should be a priority)."

"In my opinion I think by improving this route on N16 it would have a big impact for cross border trade with heavy goods vehicles and would also for tourists travelling north and south."

"Access in and out of driveway both to farm yard and dwelling house is a safety issue due to poor visibility and speed of drivers..."

"It is a very dangerous stretch of road which is not suitable to the high volumes of traffic which use it, especially commercial vehicles and the large volume of northern traffic who may not be familiar with it."

"...Exit/Entry to our road (L4711) is on a bend making exit to the south and entry from the north hazardous. The present condition of the N16 is extremely dangerous and unsuitable for the volume of traffic using it and as it is the main route from Sligo to Belfast it needs urgent and major upgrading.
"HGV traffic very dangerous to cycling/runners..."
"At several points between Barroe and Glencar we have had a number of serious accidents as a result of the poor condition of this route. The large increase in vehicle numbers has seen problems in the condition of road surfaces along the route also leading to accidents and trucks leaving the road as a result of verges crumbling..."
"High number of accidents on N16 owing to current bends and narrow road, Particularly in adverse weather conditions. High volume of lorries use the road - difficult for 2 lorries to meet in places."
"Very frustrating road to drive, overtaking lanes on a road like this would vastly improve things (new zealand model)."
"At present very dangerous bends. Requires a number of overtaking lanes."
"This route needs to be made safer, wider and more straight to reduce risk on the road."
"Working 33 years at Manorhamilton, I have been on the receiving end of three crashes using this route."
"While the impact on flora and fauna is important, people come first. Consideration should be given to a route north of the present N16 at Gortnagrelly, following the direction of L7411, crossing the R3404 and rejoining the N16 at Lugatober."
"Important to consider that no additional traffic be using the shannon eighter / old bundoran route: - It is a residential area mainly, - Already busy at peak times with traffic entering Sligo from Bundoran Road and Calry/Manorhamilton Road, - Existing traffic have little or no heed on speed limits, - Speed ramps not wanted outside residents either."
"Why not consider a new road to Enniskillen following the old railway line from Collooney?"
"Sightlines exiting from the Carncash/Teesan Road onto N16 at Doonally Crossroads are very poor. Cars travelling North on the N16 from Sligo town towards Manorhamilton travel at very high speeds and exiting the Doonally crossroads junction can be particularly dangerous. Temporary signage that is placed on the Eircom poles (particularly around election time) and lack of grass cutting also blocks visibility at this junction. Public lighting at this particular location would be an advantage."

5.5.1.1 Statutory and Non-Statutory Bodies

The following statutory and non-statutory bodies were written to following the development of the Constraints Area for the project:-

- Commissioner of Public Works in Ireland;
- Fáilte Ireland;
- An Taisce- The National Trust for Ireland;
- The Arts Council/An Chomhairle Ealaíon;
- The Heritage Council;
- Inland Fisheries Ireland;
- Córas Iompair Éireann;

- National Roads Authority;
- Údarás na Gaeltachta;
- Environmental Protection Agency;
- Department of Communications, Energy and Natural Resources;
- Department of Arts, Heritage and the Gaeltacht;
- Minister for the Environment, Community and Local Government;
- Irish Aviation Authority;
- Border Midlands and West Regional Assembly;
- National Parks and Wildlife Service;
- Health Services Executive;
- Minister for Justice and Equality;
- Electricity Supply Board;
- Irish Central Border Area Network (ICBAN) Ltd.;
- Leitrim County Council;

In addition to the Constraints Area, the correspondence issued to each body outlined the status of the project and a general background in terms of policy and context setting.

Observations were received during this process from the following bodies:

- Geological Survey of Ireland - Department of Communications, Energy, and Natural Resources;
- An Taisce- The National Trust for Ireland;

Additional correspondences were also conducted with the NPWS and the IFI and are also referenced in Volume 3 (Flora, Fauna & Fisheries – Constraints Study) of this report.

5.5.1.2 Local Representatives

Local Representatives were briefed on the proposed project via:

- Information letters issued in June 2015; and
- A presentation in the Council Chamber on the 27th of July 2015;

v. CONSIDERATION OF ALTERNATIVES

6 The Consideration of Alternatives

6.1 Introduction

The 'Consideration of Alternatives' is a key element of the planning process, as it represents the rational to a narrowing of options and it recognises the importance of avoiding impacts at an early stage. The following Chapter sets out the methodology, in relation to how alternatives are considered in the N16 route selection process.

6.2 Methodology for Considering Alternatives

6.2.1 TII PMG and TII PAG

The methodology for considering alternatives is generally in accordance with the guidelines set out in the TII Project Management Guidelines (PMG) 2010 and the TII Project Appraisal Guidelines (PAG) Unit 4.0 (Consideration of alternatives and options). The initial process commenced, following the completion of Phase 1, of the PMG (Feasibility Stage), with a study of the various forms of scheme alternatives. The study, which was carried out at a broad geographical scale, initially considered in a simplistic form, all the possible interventions, for the N16 as it occurs in County Sligo.

6.2.2 Alternatives Considered

6.2.2.1 Range of alternatives

The range of alternatives considered, can generally be classified under the following headings:

- Pre Constraints Study Alternatives;
- 'Do-Nothing' and 'Do-Minimum' Alternatives;
- 'Do-Something' Alternatives, including:
  - Public Transport Alternative;
  - Traffic Management Alternative;
  - Upgrade in accordance with the Design Manual for Roads and Bridges (DMRB);

The following chapter of the Route Selection Report, sets out the assessment process in relation to the foregoing.

6.3 Pre Constraints Study Alternatives

The first step in the process as already outlined, was the consideration at a wide geographical scale, of those options which were subsequently considered to be unfeasible. These options generally included:

- Consideration of 1996 routes (as per section 3.4.1 of this Main Report);
- Potential regional road corridors;
- N16/N15 inter connection.

Sections 6.3.1, 6.3.2 and 6.3.3 of this report, outlines the assessment of these foregoing options.

6.3.1 Consideration of 1996 Routes

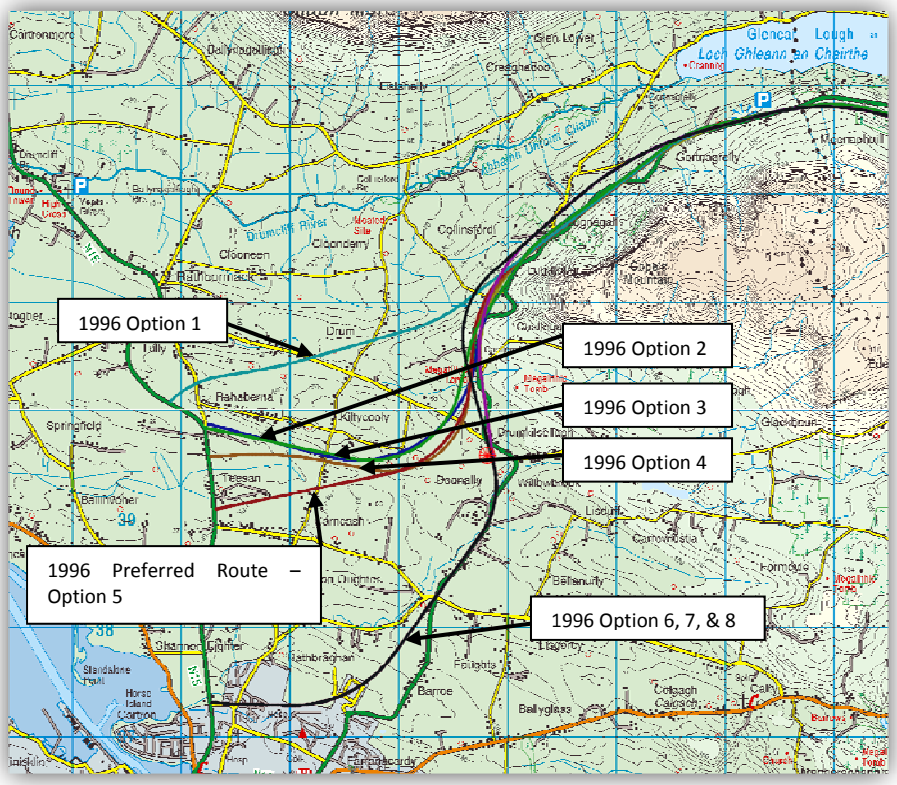
6.3.1.1 General

In examining Feasible Route Options for the N16, a review was initially undertaken of the routes put forward in the 1996 Route Assessment Report. In considering these routes, it is important to acknowledge that the process (at that time) predated the TII Project Management Guidelines. It is also worthwhile to note, that although some landowners may have been contacted, wider consultation in the overall study area was not an active requirement.

At that time, 8 routes were initially established, with the Preferred Route considered to be the Red Route as depicted in Figure 6-1 (Option 5 of the 1996 routes). Options 1, 2, 3 and 4 (1996 options) occurred to the north of the 1996 Option 5, and were coloured cyan, blue, green and brown respectively.

1996 Options 6, 7 and 8, were three additional options which generally merged into one black route south of *Drumkilsellagh*.

Figure 6-1: Preliminary Options Assessment 1995/1996



6.3.1.2 Review of 1996 Options 1, 2, 3 & 4

6.3.1.2.1 *The interaction of the N16 with the N15*

An important assumption made at the time of the 1996 assessment, was that the N15 would be upgraded to a Dual Carriageway cross section online. At the time, this influenced the N16 Route selection design process, insofar as, such an arrangement provided an attractive tie in point (to the N15) for some routes. This assumption was however compromised in 2006, with the selection of a

Route Corridor for the N15, staggered to the west of the existing N15, at a point just north of Sligo urban area as outlined in Figure 3-10.

It was considered that the N15's subsequent design influence on the route options put forward for the N16 in 1996, would be to affect certain aspects of some route options. This includes *inter-alia*:

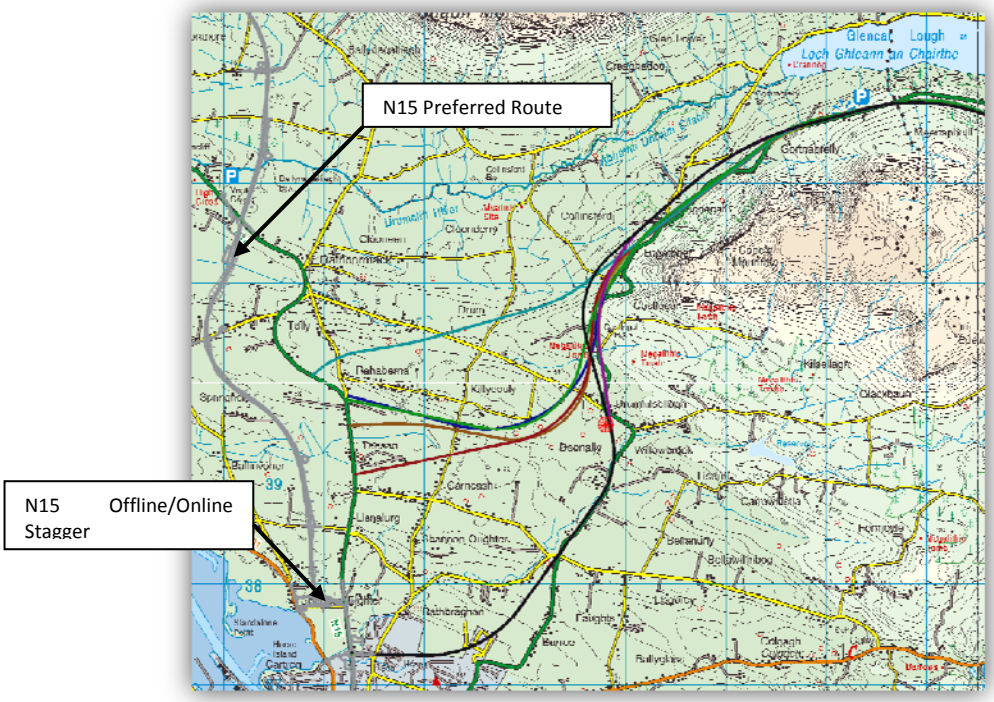
- Increased aspects of physical engineering;
- Decreased journey time benefits; and
- Safety impacts.

It was felt in this regard, that such influences could be significant enough, to render some of the previously considered routes, unfeasible from a current day perspective.

In general, when the N16 connection point to the N15 is considered, the following resulting effects are obvious. These effects increase the further north any such junction is positioned on the N15.

- In a 'Do-Nothing' scenario for the N15 and a 'Do-Something' scenario for the N16:
    - N16 traffic would be diverted onto the existing N15 route, thereby potentially impacting upon traffic conditions on the latter; or
    - An additional localised upgrade (in addition to any future realignment specific to the N15) could potentially be required for the N15, from the N16 connection point back to the Inner Relief Road (or its extensions, e.g. Hughes Bridge widening);
- In a 'Do-Something' scenario for the N15 and a 'Do-Something' scenario for the N16, either:
    - A full grade separated junction would be required connecting the proposed N16 to the proposed N15 (See also section 6.3.3 of this report); or
    - The localised upgrades described above for the N15 in its 'Do-Nothing' scenario, would potentially also be required in the 'Do-Something' scenario;

Figure 1-2: N15 Sligo to County Boundary Preferred Route and 1996 Routes



In order to assist in the selection process, a trip attractions assessment of the N16 was carried out, with reference to the National Transport Model information and POWSCAR data. This assessment is expanded upon in 6.3.1.2.2.

6.3.1.2.2 *N16 Trip Attractions*

As part of the Irish Census (2011), the Central Statistics Office (CSO) produced the Place of Work, School, or College Census of Anonymised Records (POWSCAR) database. The POWSCAR dataset provides detailed data on the journey to work/education at Electoral Division (ED) level. This data includes:

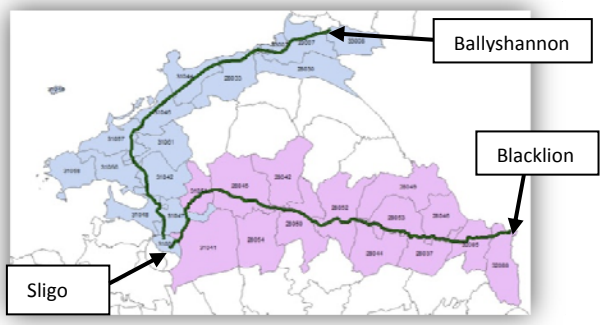
- Origin (residence) and destination (place of work/education);
- Time of departure; and
- Travel mode.

Outputs from the POWSCAR dataset, provided the data required to construct journey to work (commuting) and journey to education origin-destination (O-D) demand matrices for use in the TII National Transport Model (NTM).

This information proved to be useful, in terms of establishing the interaction between the N16, Sligo urban area (and other routes to the south), and the N15 to the north. In this regard, information was extracted from the NTM for the N16 between Sligo and the boundary with Northern Ireland, and for the N15 between Sligo and Ballyshannon (See Figure 3-10). The results demonstrate that:

- c. 88% of traffic on both the N15 and N16 are Sligo urban area bound trips;
- c. 4% of traffic on the N16 is attracted to the Rosses Point Area;
- The balance (c. 8%) is attracted to the N15, with c. 6% of these trips attracted to the area south of *Drumcliff*;
- The N15 traffic which are attracted to the N16, are primarily attracted to the section of the N16 closest to Sligo;

Figure 6-2: ED Map N15 (Sligo to Ballyshannon)/ N16 (Sligo to Northern Ireland boundary)



6.3.1.2.3 *Conclusion on 1996 Options 1, 2, 3 and 4*

Based on the foregoing, it was established that those options north of Option 5 (Preferred Route, 1996) were unfeasible from a current day perspective. To summarise, the basis for this conclusion is as follows:

- The attraction point, for c. 92% of traffic on the N16 is Sligo, or a point south of the Rosses Point junction. Therefore, journey times would be increased the further north on the N15 which any N15/N16 junction would be placed;
- The closer any such junction can be located to the N15's online/offline stagger point would result in the following:
  - A reduction in the need for a grade separated junction to cater for both schemes in a 'Do-Something' scenario;
  - A reduction in the length over which additional traffic is added to the N15 in a 'Do-Something' or the 'Do-Nothing scenario'. This obviously results in a lesser need for improvements on the N15 as a result of a connecting N16 scheme;
- Geometry and existing junctions on the existing N15 in the *Teesan/Rahaberna* area (general area of Options 1, 2, 3 & 4 connections) make a connection less desirable;

6.3.1.3 Review of 1996 Options 6, 7 & 8

Although Options 6, 7 and 8 of the 1996 routes, gave a more direct entry point into Sligo, it is observant that the aforementioned routes would have unavoidable direct significant impacts on the since constructed AbbVie Pharmaceutical Plant and a new housing estate in *Rathbraghan*. For this reason, these options were also considered unfeasible from a current day perspective.

6.3.1.4 Review of 1996 Option 5

The preferred route arising from the 1996 assessment, as already outlined, was option 05. Of those options examined in 1996, this option still appears to have been the most viable. In this regard, it was considered appropriate that this option should form one of the Feasible Route Options for the current Route Selection Process. In this regard, the historical option 05 was upgraded to satisfy the current design standards and the option now forms, from this point forward, Feasible Route Option 01A.

6.3.2 Potential regional road corridors

6.3.2.1 Cross Country Routes between Sligo and Manorhamilton

There are a number of cross country routes, which in addition to the N16, provide alternative connections between the Manorhamilton and Sligo. These routes were each examined in terms of their physical constraints – As outlined below, this revealed that none of these options could be considered 'Feasible Route Options'.

From an economic perspective, it is notably significant, that each of the proceeding corridors would require full construction works over their entirety within both counties Sligo and Leitrim. This is notable in comparison to the N16 where approximately 5km are already improved in County Leitrim, meaning the costs and impacts associated with any versions of the foregoing, would not compare with shorter improvements required on the N16.

6.3.2.1.1 *Manorhamilton to Sligo (Route 1, via Dromahair and Calry)*

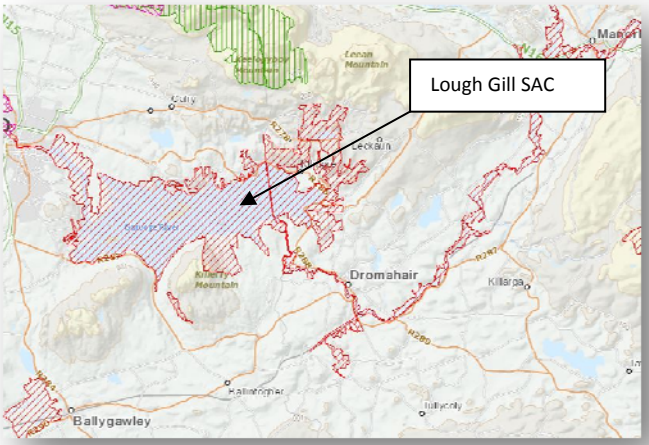
This alternative travel route, traverses on regional roads R280, R287, R288 (through the village of Dromahair) and the R286 before entering Sligo at *Bellanod*e. The route measures approximately 32.4km which is over 8km longer than the main N16 national primary route.

On an examination of any possible realignment of this route, which would seek to shorten the above distance, the following significant constraints are obvious:

- The Bonet River;
- Carrigeencor Lough;
- Lough Anarry;
- Benbo Mountain and the high lands around *Aghameelta Barr, Bohy, Coorycullen* and *Rubbal*;
- The village of Dromahair;
- Lough Gill and the highland areas between *Moneyduff* and *Fivemilebourne*;
- Colgagh Lough;
- Considerable residential development along the regional and local roads between *Kiltycahill* and Sligo; and
- Lough Gill SAC (See Figure 6-3).

Considering the foregoing constraints; it was concluded that this particular corridor did not lend itself to the design of any 'Feasible Route Option(s)'.

Figure 6-3: Lough Gill SAC



6.3.2.1.2 *Manorhamilton to Sligo (Route 2, via Dromahair and Carrowroe)*

This alternative travel route traverses westward from Manorhamilton on the N16, before turning off on a local county road in Leitrim and travelling in a southerly direction to connect with the R288 in the village of Dromahair. It continues to the R287, before entering Sligo at *Carrowroe* where it connects with the R284 (old Dublin Road). The route measures approximately 28.2km, which is over 4km longer than the main N16 national primary route.

On an examination of any possible realignment of this route, which would seek to shorten the above distance, the following significant constraints are obvious:

- The Bonet River;
- Carrigeencor Lough;
- The village of Dromahair;
- Killery Mountain;
- Slieve Dargan Mountain;
- Lough Gill;
- Considerable residential development along the regional and local roads between *Aghamore* and *Carrowroe*; and
- Lough Gill SAC.

Considering the foregoing constraints; it was concluded that this particular corridor did not lend itself to the design of any 'Feasible Route Option(s)'.

6.3.2.1.3 *Manorhamilton to Sligo (Route 3, via Dromahair and Carrowroe)*

This alternative travel route, traverses south from Manorhamilton on regional road R280, before diverting south west on regional road R287 and diverting to the west in Dromahair along the R286 which it follows before entering Sligo at Carrowroe, where it connects with the R284 (old Dublin Road). The route measures approximately 29.6km which is over 5.5km longer than the main N16 national primary route.

On an examination of any possible realignment of this route, which would seek to shorten the above distance, the following significant constraints are obvious:

- The Bonet River;
- The village of Dromahair;
- Killery Mountain;
- Slieve Dargan Mountain;
- Lough Gill;
- Considerable residential development along the regional and local roads between *Aghamore* and *Carrowroe*; and
- Lough Gill SAC.

Considering the foregoing constraints; it was concluded that this particular corridor did not lend itself to the design of any 'Feasible Route Option(s)'.

6.3.2.1.4 *Manorhamilton to Sligo (Route 4, via Shanvaus Cross and Calry)*

This alternative travel route, traverses west from Manorhamilton on the N16 before diverting off to the south at a junction known locally as Shanvaus Cross. The route follows the R286 southwards before connecting with the R278 which travels in a predominately westerly direction entering Sligo in *Bellanode*. The route measures approximately 21.5km, which is approximately 2.5km shorter than the main N16 National Primary Route.

On an examination of any possible realignment of this route, which would seek to shorten the above distance, the following significant constraints are obvious:

- Benbo Mountain to the east;
- Highlands in *Morerah* to the west;
- Doon Lough and small mountainous outcrops in its environs;
- Small mountainous outcrops interspersed with Drumlin deposits in the *Newtownmanor, Fivemilebourne, Carrickoneilleen* and *Colgagh* areas;
- Considerable residential development adjacent the regional roads along its entirety, but particularly west of *Loughanelteen*; and
- Lough Gill SAC.

Considering the foregoing constraints; it was concluded that this particular corridor did not lend itself to the design of any 'Feasible Route Option(s)'.

6.3.3 **N16/N15 Inter Connection**

Consideration was given at an early stage of the project to the viability of a connection between the 1996 Preferred Route (Current Feasible Route Option 01A) and the proposed N15 Sligo to County Boundary Realignment. This particular option was considered unfeasible for the following reasons:

(1) Engineering:

Such an option would require significant additional engineering features including *inter alia*:

- An overbridge across the existing N15 at *Teesan*;

- A full grade separated Junction including an overbridge arrangement to cross over the proposed N15 Sligo to County Boundary Scheme;

(2) Journey Times:

Such an option would add journey times, to the Sligo destined traffic on the N16. An approximate estimate, in the absence of a full design, indicates that an additional length of between approximately 0.7km and 0.8km would be arising. Such an arrangement is counterproductive, as it reduces the economic benefits, while also making alternative routes into Sligo more attractive, such as the existing N16 at its connection with the Drum Road.

(3) Traffic Patterns:

The primary benefits of such an option would be to provide improved access to the north, however it is obvious from traffic information gathered from the National Transport Model that that such a demand does not currently exist to any notable degree;

(4) Project Twining:

Such an option would require merging the N16 Sligo to County Boundary Scheme with the N15 Sligo to County Boundary Scheme. Such a project would be considered to be unviable in the current economic climate.

(5) Other adjacent schemes:
The long term importance of the 'Sligo Western Bypass' is noted in the Sligo & Environs Development Plan as follows:

"Sligo City requires a Western Bypass to enable traffic not wishing to access the city to pass with ease from North to South and vice versa. A modern well planned bypass will augment Sligo's infrastructure and attractiveness for inward investment allowing it to fulfil its potential as a Gateway City.

A Feasibility Report for the 'Sligo Western Bypass', was completed in December 2008. A full route selection process did not take place at that time; however, the aforementioned Development Plan in objective T1.5.a, has stated the following restriction in relation to any future project:

At its Special Meeting of 17 November 2008, Sligo County Council resolved:
"that the Western/City Bypass should be located west of the Second Sea Road with a view to ensuring that the accepted negative impact on those people living between the two Sea roads be prevented"

The resulting effect is that any future long term strategic bypass, if deemed viable, is likely to intercept the proposed 'N15 Sligo to County Boundary' scheme somewhere in the townland of *Ballyvoher*. Connecting the proposed N16 in the vicinity of this location, could ultimately impact on the Route Selection for the 'Sligo Western Bypass' – it would also increase the scale of complexity for a junction in this area, which would require significant engineering works.

Figure 6-4: Option 1A/1B[51] and the interaction with the N15

On the basis of the foregoing and considering that an at grade roundabout in *Teesan*, would ultimately (if it is deemed required at a future stage), permit an extension westwards to the proposed 'N15 Sligo to County Boundary' scheme, or the 'Sligo Western Bypass'; a conclusion was made that a connection between the N16 Feasible Route Option 01A and the 'N15 Sligo to County Boundary' scheme is not a viable consideration at the current time (i.e. In terms of the N16 Route Selection process).

6.4 'Do-Nothing' & 'Do-Minimum' Scenarios

The 'Do Nothing' and 'Do Something' alternatives were also considered at an early stage in the Route Selection process. These alternatives, in relation to this study, are identified and considered as outlined in sections 6.4.1 and 6.4.2.

6.4.1 Do-Nothing Alternative

The 'Do-Nothing' alternative comprised an investigation of the existing road infrastructure and its ability to meet future demands for traffic and safety without any upgrade, or junction improvement works, other than routine maintenance. The results of this process, is outlined in Section 3.5.2 of the Route Selection Report.

In the case of the existing N16, the Do-Nothing scenario represents the base case, i.e. the route in its current form with only routine maintenance accounted for in its current and future ability to meet traffic and safety demands. Given the significant deficiencies already described in the foregoing sections, the 'Do-Nothing' is not considered a viable alternative in providing a 'safe' and 'efficient' national road network.

6.4.2 Do-Minimum Alternative

The TII Project Appraisal Guidelines states that the 'Do-Minimum' alternative, should include those transportation facilities and services that are either committed, or planned within the appraisal

[51] See section 7 of this report for further details in relation to the design of this route option.

period. To provide a basis of comparison, the 'Do-Minimum' alternative must include the following features:

- The maintenance of existing facilities and services in the study area;
- The completion and maintenance of committed projects, or, policies in the study area that have successfully completed their environmental review; and
- The continuation of existing transportation policies.

The 'Do-Minimum' alternative for the N16 project was based on the definition that only 'committed' improvements are included, meaning typically those that have been progressed through planning and are either under construction, or, are programmed into the capital expenditure budget.

Funding for the construction of a new bridge over the Garvogue River in the east of Sligo has been granted through the government's capital expenditure programme. This river crossing will supplement the three existing bridges in the area whilst increasing traffic permeability and thereby route choice within the urban area. It is also identified as a strategy transport objective in the Sligo and Environs Development Plan 2010 – 2016. Consequently, the proposed Eastern Garvogue Bridge (EGB) is included in the 'Do Minimum' scenario for the N16 Route Selection – This is most relevant in terms of traffic modelling and any ensuing effects arising.

The 'Do-Minimum', from an N16 road network perspective, is considered to be similar to the 'Do-Nothing' scenario as outlined in section 6.4.1.

6.5 'Do-Something' Alternatives

6.5.1 **Public Transport Alternative;**

Public Transport can generally be defined as bus and train transport available for shared use by the general public. In the case of the N16/A4 strategic route, the only form of Public Transport available is the operating Bus Service provided by both public and private operators.

The Need for an upgrade to the N16 has been set out in section 3.1 of the Route Selection Report. The Public Transport Alternative will not satisfy the Need for the following reasons:

- Point to Point 'Public Transport' will not adequately cater for the dispersed nature of the geographical zone which is attracted to the N16;

6.5.2 **Traffic Management Alternative;**

6.5.2.1 Traffic Management Alternatives

The Traffic Management Alternatives (TMA) as defined in the TII PAG *represent those which seek to respond to transportation problems by maximising the value of existing infrastructure*[52]. As recommended by PAG, the Traffic Management alternatives can include:

- *Removal of bottlenecks through targeted local investment;*
- *Local road safety improvements;*
- *Fiscal or Traffic Control measures to manage traffic demand;*
- *Public Transport Priority, capacity and/or public transport services;*
- *Corridor or area-wide improvements to pedestrian or cycling provision; and*
- *Intelligent Transport Systems to improve reliability, safety and operating capacity.*

[52] TII Project Appraisal Guidelines, 2011, Unit 4.0, Definition of Alternatives.

This option is deemed to represent the *'best'* that can be done using existing infrastructure, it is noted that in some cases this option may also fit into the Do Something DMRB upgrade outlined below.

Section 2.3.5 of the *Guidelines on a Common Appraisal Framework for Transport Projects and Programme* refers to a Management Option as follows:

> *Investment options will not always represent the most appropriate response to identified needs or objectives. Better management or pricing of existing networks and services may either reduce demand or expand the effective capacity of networks. A management option may also be more environmentally acceptable...*

The deficiencies requiring intervention in the road network, which have already been outlined in section 3.5 and section 6.4.1 of the Route Selection Report, determine the form of any Traffic Management Alternative, i.e. the latter four categories described above will not resolve the safety and efficiency deficiencies imparted by the route.

In this regard, possible Traffic Management Alternatives for the N16 have been determined to include local road safety measures and the removal of bottlenecks[53] through targeted local investment.

6.5.2.2 Assessment

In order to establish if the N16 would lend itself to targeted local investment, or local road safety improvements, a geometric design assessment has been carried out, to establish the extent and associated effects ...*of the best that can be done...* with the existing alignment.

The approach taken, to satisfy the foregoing, was to develop design's which would match as far as is practicable, the corridor of the existing N16, while at the same trying to improve the significant geometric deficiencies. As it is clear, that a design prepared for a 100kph design speed (which is standard for national primary roads) will require significant areas of greenfield realignment, it was considered appropriate to consider reducing the tiers of design standards, from that which would normally be appropriate on national primary roads, and to establish if this would provide any greater benefits over the standard approach, specifically in terms of cost and environmental impacts.

In order to achieve this, two separate design options were prepared for the rural section between the AbbVie Roundabout and the County Boundary with Leitrim. The first design option; was a one step reduction in design speed terms, from 100kph to 85kph (which would be a typical design speed for regional roads and good quality local primary roads). The second design option, was a two step reduction in design speed terms from 100kph to 70kph (which would be a typical design speed for lower quality regional roads and local primary roads).

The characteristics of these designed options were then tabulated in order to establish if they provided viable options which would be economically, or environmentally better solutions to a standard 100kph design option. The resulting effect is outlined broadly in Table 6-1, the main observations are:

- Between 51%[54] and 46%[55] of the route will still require greenfield realignment. This is owning

[53] 'Bottlenecks', for the purposes of this assessment, are defined to be a serious of substandard horizontal and vertical curves, resulting in 'Stopping Sight Distances' which have the effect of reducing speeds and causing platoon's of traffic;

[54] 70kph Design Speed

[55] 85kph Design Speed

to the poor nature of the existing horizontal geometry;

- Of the remaining sections which are online, full vertical reconstruction[56] will be required over approximately 42%[55] and 48%[54]. This is primarily as a result of the poor nature of the existing vertical geometry;

The foregoing points, from an engineering perspective mean that a reduction in 'Design Speed' will not significantly reduce the engineering aspects associated with the realignment. In addition, it is considered that the 42% to 48% of online improvements would only (due to the vertical differences) serve to require a closing of the national primary route in order for upgrade works to be undertaken. Further points which are also of significance include:

- There is significant impacts on property at locations where road widening and realignment is required;
- A significant number of direct access arrangements remain, particularly around cluster locations such as at *Barroe* and *Doonally* townlands;

Additionally, the aforementioned designs will not be, as 'safe' or 'efficient' as the comparable 100kph designs.

Table 6-1: Traffic Management Alternative – Some Characteristics

Characteristics of TMA	*Design Speed*	
	70kph	85kph
Length of Option (m)	7,985m	7,943m
Length of Option which requires Greenfield Realignment (m)	4,070m	3,650m
Length of Option ONLINE BUT which require full vertical reconstruction (km)	3,395m	3,814m
Properties potentially required under a CPO (no.)	8	13
Properties where garden space is required (no.)	30	22
No. of Direct Accesses which remain (no.)	38	27

In consideration of the foregoing assessment, it can be concluded that the Traffic Management Alternative is not a viable intervention.

6.5.3 Upgrade in accordance with the DMRB

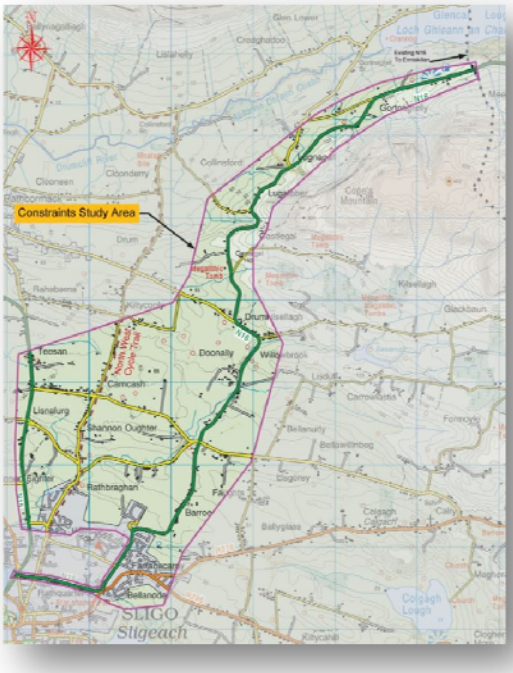
The process as outlined; evolved to indicate, that the only viable solution to the interventions required, on the N16 in County Sligo, is an upgrade which is consistent with the requirements of a national primary road and the DMRB. The following sections, outlines the process used to develop the 'Feasible Route Options' for this solution.

6.5.3.1 Constraints Study Area

The definition of the Constraints Study Area (See Figure 6-5), was guided by the initial assessment of unfeasible options, which has already been described in section 6.3 of this report.

[56] Full reconstruction considered where the vertical alignment deviates from the existing by greater than 0.6m

Figure 6-5: Constraints Study Area – July 2015



6.5.3.2 Road Development Guidelines

National road projects are planned and delivered in accordance with a common framework that helps to ensure a consistency in the approach throughout the National Road Network. This common framework is described in a series of documents including *inter-alia* the following:

- The TII; Project Management Guidelines;
- The TII; Project Appraisal Guidelines;
- The TII; Cost Management Manual; and
- Environmental Legislation, Regulations and Guidelines;

6.5.3.2.1 *TII Project Management Guidelines and Project Appraisal Guidelines*

The TII Project Management Guidelines, is intended as the main guidance document with regard to the management of all national road projects from inception through planning, execution and closeout. It forms the overarching document that ties together the other elements of the project development process. The route selection process is Phase 2 of a 7 Phase process.

The TII Project Appraisal Guidelines (PAG) was published in October, 2016. These new Guidelines apply to the appraisal process of national road projects and programmes. The PAG incorporates the requirements of project appraisal which are set out in the following government publications:

- 'The Public Spending Code', Department of Public Expenditure and Reform, publicspendingcode.per.gov.ie; and
- 'Common Appraisal Framework for Transport Projects and Programmes', Department of Transport, Tourism and Sport (2016).

The route selection and appraisal process is project specific, but follows the guidelines set out in the TII Project Management Guidelines and the current recommendations in the new PAG, i.e.

6.1 Narrowing of Options

Throughout the planning and project development process the primary nature of the decisions to be made is a selection of the preferred option through a narrowing of options. The Option Selection (Phase 2) process is split into three distinct stages within the TII Project Management Guidelines, each requiring a greater level of assessment and appraisal. The three stages are referred to as:

- *Stage 1: **[Preliminary Options Assessment]**[57];*
- *Stage 2: **[Project Appraisal Matrix]**; and*
- *Stage 3: **[Selection of a Preferred Option]**.*

***Stage 1 - Preliminary Options Assessment** - develop a number of feasible options and carry out a Multi-Criteria Analysis (MCA) under the assessment criteria of **[Engineering]**, **[Environment]** and **[Economy]**. This will result in a refined number of options (minimum of 4, Do-Nothing or Do-Minimum and a least 3 Do-Something Options)...*

***...Stage 2 - Project Appraisal Matrix** - following Stage 1, carry out a full CBA and MCA of the quantifiable and non-quantifiable impacts of these options (under the six CAF Criteria of **[Economy]**, **[Safety]**, **[Environment]**, **[Accessibility & Social Inclusion]**, **[Integration]** and **[Physical Activity**)...*

***...Stage 3 - Preferred Option** - after the completion of Stage 2, select a Preferred Option for the Scheme. Following this, prepare a Project Appraisal Balance Sheet (PABS) to summarise the impact of the Preferred Option.*[58]

6.5.3.2.2 *TII Cost Management Manual*

The TII Cost Management Manual, has been used in the development of the 'Options Comparison Estimate' which is described in Volume 2 of the Route Selection Report.

6.5.3.2.3 *Environmental Legislation, Regulation and Guidelines*

The TII has developed a comprehensive suite of Environmental Guidelines for the planning, design and construction phases of National Road Projects. These have guided the surveys and assessment methodologies for each of the appropriate environmental topics in order to assist in the identification of the preferred route corridor.

6.5.3.3 Selection of Road Type

An assessment of the Road Type to be put forward for the N16 realignment between Sligo and the County Boundary has been undertaken and is set out in Volume 2, Part B of the Route Selection Report.

The assessment was carried using the following criteria:

(1) The Guidance set out in the DMRB;

(2) Consistency of Network Layout;

(3) Reducing the Environmental Impacts; and

(4) Scale/Construction Costs;

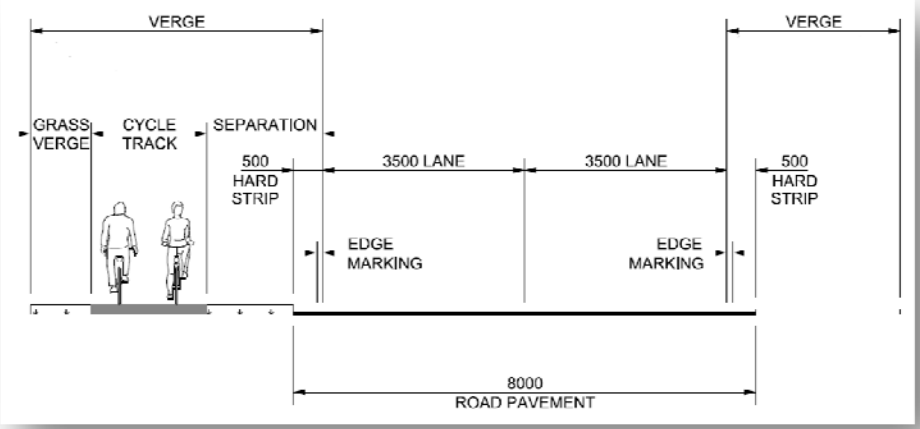
[57] Authors emphasis

[58] Project Appraisal Guidelines for National Roads Unit 4.0 - Consideration of Alternatives and Options, PE-PAG-02013, October 2016

The assessment concluded the most appropriate Road Type to be a Type 2 Single Carriageway (See Figure 6-6) which generally consists of;

- 2 no. 3.5m carriageways supported by 0.5m hard strips and 4.5m grass verges (5m total) on each side. In this cross section, there is a requirement for the provision of cyclist/pedestrian facilities on one side which will cater for both directions of travel, this results in a 3m wide paved track offset 1.5m from the edge of the paved surface, resulting in an increase in the grassed verge area of 1m on one side – Depending on the route selected.

Figure 6-6: Type 2 Single Carriageway



6.5.3.3.1 *Junction Strategy*

The junction strategy will be influenced by projected traffic volumes, however for the purposes of Initial Sketch Arrangement (at Route Selection Stage) and in accordance with the DMRB (DN-GEO-03060), the junction types used during the design of various route options included:

- Simple T Junctions, or, staggered Right – Left junctions, for side road traffic with less than 600 AADT. This arrangement may be supplemented with Ghost Islands in certain areas;
- Roundabouts for:
  - Change in cross section;
  - Tie in points to the urban area;
  - Cross road situations in the Urban Area; or
  - Very highly trafficked local roads;
- Traffic Signals may also be appropriate for cross road situations in the urban area.

6.5.3.3.2 *Treatment of Direct Accesses (lightly trafficked and minor junctions)*

TII DMRB DN-GEO-03060 provides further guidance in relation to the treatment of direct accesses and minor junctions:

> *The overriding principle is that direct vehicular access onto national roads shall be avoided as far as practicable.*

The design process for the N16 will adopt this approach, insofar as is reasonably practicable. The incorporation of these accesses into side roads, via the potential provision of parallel tracks, will

concentrate turning movements onto and off the proposed N16, thereby improving safety aspects and Full Overtaking Sight Distance on the mainline.

Notwithstanding the foregoing, it should be noted, that each direct access arrangement will be considered on a case-by-case basis. There may be instances where it is impracticable, or where significant engineering (via the provision of parallel tracks) makes the collection (to the local network) of some of these accesses unviable.

The case-by-case basis will focus on *inter-alia*:

- Journey Time and Community Severance;
- Value Engineering; and
- Safety.

6.5.3.4 Preliminary Options Assessment

The design of Route Options is an iterative one and commenced with the development of 'Feasible Route Options'. There were 11 initial Feasible Route Option's, with 2 additional extensions to Options 01A and 02A, giving a total of 13. These options are described figuratively in Volume 5 (See Fig N16-RS-003 and N16-RS-006 to 034) of the Route Selection Report and grammatically in section 7.3. The routes can be separated into four strategic options as outlined below:

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A;
  - Red – Feasible Route Option 01A/01B;
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A
  - Yellow - Feasible Route Option 02A/2B
- *Rathbraghan* to the County Boundary:
  - Green - Feasible Route Option 03
  - Light Blue - Feasible Route Option 04
  - Lime Green - Feasible Route Option 10
  - Grey – Feasible Route Option 11
- AbbVie Roundabout to the County Boundary:
  - Blue - Feasible Route Option 05;
  - Pink - Feasible Route Option 06;
  - Brown - Feasible Route Option 07;
  - Black - Feasible Route Option 08;
  - Purple - Feasible Route Option 09;

6.5.3.4.1 *Stage 1 – Part 1 - Preliminary Options Assessment (Feasible Route Options)*

The Feasible Route Options, were subjected to the Stage 1 – Part 1: Preliminary Options Assessment which is expanded upon in section 9 of this Main Report.

The assessment was undertaken by a multi disciplinary range of specialists as outlined in Table 6-2. Individual Reports are expansive and are in this regard, for the purposes of brevity, summarised in the aforementioned section 9 of the Route Selection Report. An expansion of the assessment is provided in Volumes 2, 3, and 4 which accompany this Main Report. In addition, Volume 5 (Figures)

provides information in relation to route options design, the overall study area and impact assessment.

Table 6-2: Preliminary Options Assessment

POA Framework Category	Discipline	Body Responsible
Engineering	Road Engineering	SCC National Roads Project Office
	Road Safety Impact Assessment	SCC National Roads Project Office
	Traffic	Jacobs Engineering
Economics	Options Comparison Estimate	SCC National Roads Project Office
Environment	Landscape & Visual	RPS Ireland Ltd.
	Flora, Fauna & Fisheries	RPS Ireland Ltd.
	Agricultural Property	John Bligh & Associates
	Non-Agricultural Property (Domestic, Industrial, Commercial etc.)	John Bligh & Associates
	Noise & Vibration	Envest Environmental
	Air Quality & Climate Change	Envest Environmental
	Hydrology & Hydrogeology	Hydro Environmental
	Soils & Geology	Roughan & O'Donovan
	Archaeology & Cultural Heritage	ACSU
	Architectural Heritage	ACSU
	Socio Economic	Optimize Consulting
	Urban Planning	The Planning Partnership

The 'Framework Matrix' ranking template and associated 'Scorecard' developed for the 'Preliminary Options Assessment' in the Route Selection Report was applied (See Section 10.2.1 for Matrix details). Each route was relatively ranked in order of preference from 1 to 13. These ranks were then applied to the 5 separate 'Preferences' as outlined in Table 10-2.

The outcome of the 'Preliminary Options Assessment' (Part 1) is outlined in section 9.6.2 of the Route Selection Report. This resulted in a refinement of the route options, which included discounting of certain options and applying design changes to others which also included the breaking down and amalgamation of certain sections.

These options are described figuratively in Volume 5 (See Fig N16-RS-004 and N16-RS-035 to 051) and grammatically in section 10.1 of this Main Report. The routes can be separated into three strategic options as outlined below:

- N15 (connection at *Teesan* Td.) to the N16 County Boundary:
  - Red – Feasible Route Option 01A – v2;
  - Red – Feasible Route Option 01A/01B – v2;
- N15 (connection at *Shannon Oughter*) to the N16 County Boundary:
  - Yellow - Feasible Route Option 02A – v2;

- Yellow - Feasible Route Option 02A/02B – v2;

- AbbVie Roundabout to the County Boundary:
  - Blue – Feasible Route Option 05;
  - Black - Feasible Route Option 08 – v2;
  - Brown - Feasible Route Option 12 (and option 12-v2);

6.5.3.4.2 *Stage 1 – Part 2 - Preliminary Options Assessment (Refined Route Options)*

The Refined 'Feasible Route Options' described in section 6.5.3.4.1 were subjected to a second stage of 'Preliminary Options Assessment' defined within this report as 'Part 2'. This assessment resulted in a further refinement of Route Options down to 3, which are described figuratively in N16-RS-005.

The routes can be separated into two Strategic Options as outlined below:

- N15 (connection at *Teesan Td.*) to the County Boundary:
  - Red – Feasible Route Option 01A – v2;

- AbbVie Roundabout to the County Boundary:
  - Blue – Feasible Route Option 05;
  - Brown - Feasible Route Option 12 (and option 12-v2);

6.5.3.5 Stage 2 - Project Appraisal Matrix

The Refined Route Options as described in 6.5.3.4.2 were subjected to the Stage 2 (Project Appraisal Matrix) which is described in Section 11 of the Route Selection Report. The objectives of the scheme are appraised in accordance with the national transport planning policy using the common appraisal framework based on the following criteria:

- Economy;
- Safety;
- Environment;
- Accessibility;
- Integration; and
- Physical Activity.

This appraisal will be expanded upon during the proceeding Phases of the NRA (now TII) Project Management Guidelines.

7 The 'Feasible Route Options'

7.1 Introduction

The following paragraphs provide a brief overview of the Feasible Route Options (FRO) for the N16 Sligo to County Boundary Realignment. The options have not been extended to consider implications with regard to domestic and agricultural accesses, however the objective will be to reduce and if possible eliminate these accesses as part of the design process which will follow. It is expected, that this will result in the provision of parallel accommodation tracks, collecting the aforementioned accesses to the local road network which will in turn connect to the National Primary (N16) Route.

7.2 Design Standards

The following describes the design standards which were used in the development of the 'Feasible Route Options'. The same standards apply to the Refined 'Feasible Route Options'.

7.2.1 Design Criteria

The various designs presented for the purposes of Feasible Route Options have generally been developed in accordance with the TII Design Manual for Roads and Bridges (DMRB). Although numerous standard documents are referenced during the design process, some of the more relevant design standards at the current stage of the process include TII DMRB standard DN-GEO-03031 (formerly TD 09/12, Road Link Design), DN-GEO-03043 (formerly TII TD 41-42/11, Geometric Design of Major/Minor Priority Junctions and Vehicular Access to National Roads) and DN-GEO-03036 (formerly TII TD 27/14, Cross Sections and Headroom). Generally, the Feasible Route Options of the Route Selection Report have been developed to the 'Desirable Minimum' standard, however it is inevitable that 'Relaxations' and 'Departures' from Standard will be required in localised areas of each route option; such instances are documented during the 'Engineering Assessment' of each route option.

7.2.2 Design Speed and Classification

Roads are designed such that their geometric alignment features, e.g. horizontal and vertical curvature, sight distances, super-elevation, etc, provide for a Design Speed that is consistent with the anticipated vehicle speed of the road and that the road cross-section is adequate to ensure the required capacity is achieved.

The Design Speed determined for the proposed N16 Sligo to County Boundary realignment is 100kph.

7.2.3 Sight Distances

Stopping Sight Distance and Full Overtaking Sight Distance (FOSD) are the two sight distance parameters prescribed in relation to road design and have been calculated for each of the indicative alignments.

7.2.4 Horizontal Alignment

The horizontal alignment of a road comprises a series of straights joined by curves representing the best fit to the planimetric features between two tie-in points having regard to engineering, environmental and economic considerations.

Horizontal curves are used to provide safe smooth transitions between changes in horizontal alignment direction. There are three components to every curve:

- The Circular Curve and its associated super elevation;
- The transition curve at either end; and
- The straights/ tangents connected by the curve.

Horizontal alignments complying with the design parameters have been developed for each corridor option.

7.2.5 Vertical Alignment

The vertical alignment of a road scheme comprises a series of straights (gradients) joined by curves representing the best fit to the existing topography between two tie-in points having regard to engineering, environmental and economic considerations.

The desirable maximum gradient for single carriageway national roads (Type 1 and 2) is 5% while that for local roads is 7%. These can be relaxed to 6% and 8% respectively in difficult conditions. All roads provided as part of the Route Selection process generally comply with these requirements. There are no absolute minimum gradients, although, a minimum gradient of 0.5% is recommended to be maintained wherever possible for drainage purposes.

7.3 Description of Feasible Route Options

The initially developed FRO's, comprised 13 variations of 4 Strategic Options as already outlined in section 6.5.3.4. There are similarities in certain cases between some of the Feasible Route Option's, Table 7-1 below, sets out, in a non-exhaustive format where some of the similarities exist.

Table 7-1: FRO Similarities

Route Options	General Similarities
01A, 01A/01B	FRO 01A is similar to FRO 01A/01B south of its connection with the existing N15.
02A, 02A/02B, 07	FRO 02A is similar to FRO 02A/02B south of its connection with the existing N15; FRO 02A/02B is generally similar to FRO 07 north of *Lugatober*;
02A/02B, 03, 04, 10, 11	FRO 03 is generally similar to FRO 04, 10 and 11 south of *Doonally (ED Drumcliff East);* FRO 03, 10 and 11 are generally similar south of *Gortnagrelly* townland;
05, 06, 07, 08, 09	FRO 05 and 06 are generally similar, save as, the southern tie in to the AbbVie Roundabout; FRO 07, 08 and 09 are generally similar, save as, differences south of *Doonally (ED Calry)*;

The following sections, give a very brief overview of each particular Feasible Route Option. Cross Reference should be had when reading the following to the strategic nature and similarities set out in Table 7-1.

7.3.1 Feasible Route Option 01A

Feasible Route Option (FRO) 01A, commences in the townland of *Teesan*, connecting the N16 FRO to the existing N15, via a proposed Roundabout arrangement. Improvements are proposed to the existing N15 circa 250m north and south of the tie in point, this will include a review of access arrangements for existing domestic and agricultural properties;

- The N16 from the commencement point, takes an easterly direction where it intercepts with the L-7421-0 in the townland of *Teesan*, local connectivity in this instance, is maintained via a proposed Right/Left staggered Simple T Junction;
- The FRO changes to a more northerly direction as it passes through *Kiltycooly* and *Doonally (ED Drumcliff East).* It intercepts with the L-3406-0 (Drum Road) in the townland of *Doonally (ED Drumcliff East),* which is closed to the West and connected to the East via a Simple T Junction;
- Continuing north, the FRO severs the L-74151-0 before intercepting the existing N16 in the townlands of *Drum East, Castlegal (ED Glencar)* and *Lugatober*. The connectivity of the existing N16 (in a local sense) will be maintained via a proposed parallel link to the East of the existing N16;
- Gradually changing direction to more north easterly one, through the townland of *Lugatober*, the FRO crosses on embankment over the L-7413-0, which is maintained via an underbridge and a newly designed link, which is proposed to join with the existing N16 via a Simple T Junction;
- A consistent direction of north-east is maintained through the townlands of *Lugatober, Collinsford, Lugnagall* and *Gortnagrelly.* The FRO intercepts the L-34041-0 in the townland of *Collinsford* and the L-3404-0 in the townland of *Lugnagall,* both local roads are reconnected via Simple T Junctions. The existing N16 is also severed in the townlands of *Lugnagall* and *Gortnagrelly*;
- As the FRO changes direction to a more easterly one in the townland of *Gortnagrelly*, the existing N16 is intercepted, with connectivity maintained via a Right/Left staggered Simple T Junction, which will include the L-7411-0;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 7,125m from its physical commencement point at its intersection with the N15, which is a further circa 2,500m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.2 Feasible Route Option 01A/01B

FRO 01A/01B considers FRO 01A with improvements to the existing N15, including the incorporation of detailed design elements already proposed for a separate scheme which is currently suspended at Design Stage (that is, with the exception of a section extending north from the recent N4 Hughes Bridge widening project, to a point north of the R291 junction, which is currently being progressed through design and Environmental Impact Assessment):

- FRO 01A/01B commences at the existing N16's junction with the N4/N15, the existing N16 link in this location is known as Duck Street. Upgrading the N15 to Dual Carriageway, it extends with online widening and junction improvements northwards past the R291 junction;

- From the R291 Junction the mainline continues northerly to the new Cartron Link Junction which is an at grade roundabout;

  [The N4 Traffic Improvement Scheme terminates north of the R291]

- The Cartron Link Junction (Roundabout) will serve the Cartron Link (a new road) to the West and the existing Shannon Road to the East. The Cartron Link runs West to East and intersects with the R291 to form the new Sea View Drive Junction which is an at grade roundabout. Shannon Road will be improved to form a link with the Ballytivnan Road/Old Bundoran Road;

- Approximately 500 metres north of the Cartron Link Roundabout, the proposed Scotsman's Walk East Junction is located which serves as the transition point where the mainline cross section changes from being a Dual Carriageway to a Single Carriageway. From Hughes Bridge to Scotsman's Walk East Junction the proposed mainline comprises of on-line widening and improvement. If in the future, once the N4/N15 Realignment Sligo to County Boundary is brought forward then the Scotsman's Walk East Junction may form the southern start/termination point;

- The N15 improvements will continue north with localised widening and improvements to the existing N15 including an examination of domestic and agricultural access arrangements. The FRO considers that local roads intercepted including the L-3411-0, L-7316-0 and the L-3407-0 will be maintained in a similar arrangement to the existing;

- Improvements to the existing N15 will terminate circa 250m north of the roundabout proposal for the intersection of Option 01A and the N15;

The remainder of Option 01A/01B is as per that described above for FRO 01A. FRO 01A/01B terminates at the County Boundary with Leitrim, a distance of circa 9,625m from its commencement point at its intersection with the existing N16's junction (Duck Street) with the N4/N15.

7.3.3 Feasible Route Option 02A

Feasible Route Option (FRO) 02A, commences in the townland of *Shannon Eighter*, connecting the N16 FRO to the existing N15 via a proposed Roundabout arrangement. As part of the design process a review will be carried out of existing domestic and agricultural properties in the vicinity of the potential junction.

- The N16 from the commencement point, takes an easterly direction where it intercepts with the L-7421-0 in the townland of *Shannon Eighter*, local connectivity in this instance, is maintained via a potential Traffic Signal crossroads arrangement, or a roundabout;

- Continuing easterly, local road, L-7422-0 is severed and subsequently maintained to the West and to the East via an arrangement of Simple T Junctions in the townland of *Rathbraghan*;

- Changing direction through the townland of *Shannon Oughter*, the FRO assumes a more north easterly direction, severing without connection the L-3407-0, before continuing in a similar direction through the townland of *Doonally (ED Drumcliff East)*;

- The FRO intersects the L-3406-0 (Drum Road) at its intersection with the existing N16 in the townland of *Drumkilsellagh,* a staggered right/left Simple T Junction is provided at this location to reconnect the L-3406-0 (Drum Road) and the existing N16 back into the FRO, additionally the existing N16 to the West is rejoined into the L-3406-0 via a parallel link road;

- The FRO stays online for circa 300m, before it diverts offline to the north, while still in the townland of *Drumkilsellagh*. Maintaining a generally northern direction, is severs and re-links the L-7415-0 back into the FRO in the townland of *Castlegal (ED Glencar)* before crossing the existing N16, followed by the L-7413-0 in the townland of *Lugatober*. The L-7413-0 is maintained via an underbridge while a parallel link road reconnects the existing N16 back into the L-7413-0;
- Maintaining a north easterly direction, the route severs the L-34041-0 in the townland of *Collinsford* and the L-3404-0 in the townland of *Lugnagall*. Both routes are reconnected to the N16 via a realigned section of the L-3404-0, which reconnects to the FRO with a Simple T Junction arrangement;
- The route gradually changes to an easterly direction as it enters the townland of *Gortnagrelly*, where before severing the L-7411-0, it rejoins the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,180m from its physical commencement point at its intersection with the N15, which is a further circa 1,180m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.4 Feasible Route Option 02A/02B

FRO 02A/2B, considers FRO 02A, with improvements to the existing N15, including the incorporation of detailed design elements already proposed for a separate scheme which is currently suspended at Design Stage (that is, with the exception of a section extending north from the recent N4 Hughes Bridge widening project, to a point north of the R291 junction, which is currently being progressed through design and Environmental Impact Assessment):

- FRO 01A/01B commences at the existing N16's junction with the N4/N15, the existing N16 link in this location is known as Duck Street. Upgrading the N15 to Dual Carriageway, it extends with online widening and junction improvements northwards past the R291 junction;
- From the R291 Junction the mainline continues northerly to the new Cartron Link Junction which is an at grade roundabout;

  [The N4 Traffic Improvement Scheme terminates north of the R291]
- The Cartron Link Junction (Roundabout) will serve the Cartron Link (a new road) to the West and the existing Shannon Road to the East. The Cartron Link runs West to East and intersects with the R291 to form the new Sea View Drive Junction which is an at grade roundabout. Shannon Road will be improved to form a link with the Ballytivnan Road/Old Bundoran Road;
- Approximately 500 metres north of the Cartron Link Roundabout the proposed Scotsman's Walk East Junction is located which serves as the transition point where the mainline cross section changes from being a Dual Carriageway to a Single Carriageway. From Hughes Bridge to Scotsman's Walk East Junction the proposed mainline comprises of on-line widening and improvement. If in the future, the N4/N15 Realignment Sligo to County Boundary is brought forward then the Scotsman's Walk East Junction may form the southern start/termination point;

The remainder of Option 2A/2B is as per that described above for FRO 2A. FRO 2A/2B terminates at the County Boundary with Leitrim, a distance of circa 9,360m from its commencement point at its intersection with the existing N16's junction (Duck Street) with the N4/N15.

7.3.5 Feasible Route Option 03

FRO 03 commences in the townland of *Rathbraghan*, strategically placed between the existing N15 to the West and the existing N16 to the East. The commencement point will be facilitated by a new roundabout which will provide a national link to the N16 to the West and a local link to the N15 to the East.

- The N16 from its commencement point, progresses in a northerly direction before changing to a more north easterly one through the townland of *Rathbraghan*, where the local road L-7422-0 is severed to the East and reconnected to the West.
- It continues north easterly through the townlands of *Shannon Oughter* and *Carncash,* where it severs local road L-3407-0 to the West reconnecting it to the East. It continues through the townland of *Doonally (ED Drumcliff East),* before it rejoins the existing N16 online in the townland of *Drumkilsellagh,* a staggered right/left Simple T Junction is provided at this location to reconnect the L-3406-0 (Drum Road) and the existing N16 back into the FRO, additionally the existing N16 to the West is rejoined into the L-3406-0 via a parallel link road;
- The FRO stays online for circa 300m before it diverts offline to the north while still in the townland of *Drumkilsellagh*. Maintaining a generally northern direction, is severs and re-links the L-7415-0 back into the FRO in the townland of *Castlegal (ED Glencar)* before crossing the existing N16, followed by the L-7413-0 in the townland of *Lugatober*. The L-7413-0 is maintained via an underbridge while a parallel link road reconnects the existing N16 back into the L-7413-0;
- The route changes direction to a more north easterly one as it continues to pass through *Lugatober* townland. It severs the L-34041-0 and the L-3404-0 as it passes through *Collinsford* and *Lugnagall*. The L-3404-0 is re-linked back into the FRO via a realigned Simple T Junction arrangement, while the L-34041-0 is in turn linked into the realigned L-3404-0 via a similar junction arrangement;
- Maintaining its previous general direction, the FRO rejoins the existing N16 while still in the townland of *Lugnagall,* before it again diverts off to the north east in the townland of *Gortnagrelly.* The route gradually changes direction to a more easterly one as it severs the L-7411-0 before it returns online again in the townland of *Gortnagrelly*, a Simple T Junction is provided to tie the existing N16 back into the FRO at this location;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,220m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.6 Feasible Route Option 04

FRO 04 commences in the townland of *Rathbraghan*, strategically placed between the existing N15 to the West and the existing N16 to the East. The commencement point will be facilitated by a new roundabout which will provide a National link to the N16 to the West and a local link to the N15 to the East.

- The N16 from its commencement point, progresses in a northerly direction before changing to a more north easterly one through the townland of *Rathbraghan*, where the local road L-7422-0 is severed to the East and reconnected to the West;
- It continues north easterly through the townlands of *Shannon Oughter* and *Carncash,* before it changes direction to a northerly one through the townland of *Doonally (ED Drumcliff East)* where it intersects and reconnects the L-3406-0 via a staggered Right/Left Simple T Junction arrangement. It severs the L-74151-0 in the townland of *Drum East* before changing direction to a more north easterly one crossing over the L-7413-0 which will be maintained via an underbridge;
- The route continues to pass through *Lugatober* townland. It severs the L-34041-0 and the L-3404-0 as it passes through *Collinsford* and *Lugnagall*. The L-3404-0 is re-linked back into the FRO via a realigned Simple T Junction arrangement, while the L-34041-0 is in turn linked back into in the realigned L-3404-0 via a similar junction arrangement;
- Maintaining its previous general direction, the FRO rejoins the existing N16 while still in the townland of *Lugnagall,* before it again diverts off to the north east in the townland of *Gortnagrelly.* The route gradually changes direction to a more easterly one as it severs the L-7411-0 before it returns online again in the townland of *Gortnagrelly*, a Simple T Junction is provided to tie the existing N16 back into the FRO at this location;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,310m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.7 Feasible Route Option 05

The FRO commences at the N16's junction with the N14/N15. Localised improvements which are yet to be determined, may be required within the Urban Area (this may include junction improvements and localised lane optimisation). The main physical element of the FRO, commences in the townland of *Ballytivnan*, at the centre point of the existing AbbVie Roundabout. The FRO will require consideration and potential improvement of the existing roundabout arrangement at this location:

- The FRO diverts offline through the townland of *Rathbraghan* in a north easterly direction before changing to a somewhat more northerly one passing through the townland of *Barroe.* It rejoins the existing N16 prior to entering *Doonally (ED Calry)* townland where it severs the existing cross road arrangement, with the L-3407-0 to the West and the L-3407-22 to the East, these roads will be reconnected to the FRO via a staggered Right/Left Simple T Junction arrangement. On the West side of the FRO, the L-7422-0 will be reconnected back into the L-3407-0, while to the East the existing N16 will be reconnected back into the L-3407-22;
- The route continues in a northern direction through *Doonally (ED Calry)* townland before it intersects the L-3406-0 (Drum Road) in the townland of *Drumkilsellagh* and rejoins the existing N16 online for a distance of approximately 300m. To the West, the existing N16 is reconnected to the L-3406-0 and a link to the FRO is provided which will maintain access to the national primary route. To the eastern side a Simple T Junction is provided which will reconnect the existing N16 to the FRO;
- The route diverts offline once again, before entering *Castlegal (ED Glencar)* townland, where it intersects the L-7415-0, which will be reconnected via a Simple T Junction arrangement. Maintaining its general direction and having severed the existing N16, the route passes into *Lugatober* where it turns more north easterly severing local road L-7413-0, which will be

reconnected via a staggered Right/Left Simple T Junction arrangement, in order to achieve direct access, this arrangement requires an alternative link access to the West;

- Maintaining direction, the route continues through *Lugatober*, before passing through *Collinsford* and *Lugnagall* townlands where the L-34041-0 and the L-3404-0 are respectively severed, the L-3404-0 is re-connected to the FRO via a Simple T Junction and the L-34041-0 is realigned to in turn, connect to the L-3404-0;
- The route gradually changes to a more easterly direction as it enters the townland of *Gortnagrelly*, where it rejoins the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 7,680m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.8 Feasible Route Option 06

The FRO commences at the N16's junction with the N14/N15. Localised improvements which are yet to be determined, may be required within the Urban Area (this may include junction improvements and localised lane optimisation). The main physical element of the FRO, commences in the townland of *Ballytivnan*, at the centre point of the existing AbbVie Roundabout. The FRO will require consideration and potential improvement of the existing roundabout arrangement at this location:

- The FRO stays generally online initially taking an easterly direction through the townlands of *Ballytivnan* and *Rathbraghan* before it enters *Barroe* townland where a second roundabout will be required, which will allow for a change in direction of the FRO diverting offline in a northerly direction through the townland of *Barroe* before changing to a somewhat more north easterly one. It rejoins the existing N16 prior to entering *Doonally (ED Calry)* townland where it severs the existing cross road arrangement, with the L-3407-0 to the West and the L-3407-22 to the east, these roads will be reconnected to the FRO via a staggered Right/Left Simple T Junction arrangement. On the West side of the FRO, the L-7422-0 will be reconnected back into the L-3407-0, while to the East the existing N16 will be reconnected back into the L-3407-22;
- The route continues in a northern direction through *Doonally (ED Calry)* townland before it intersects the L-3406-0 (Drum Road) in the townland of *Drumkilsellagh* and rejoins the existing N16 online for a distance of approximately 300m. To the West, the existing N16 is reconnected to the L-3406-0 and a link to the FRO is provided which will maintain access to the national primary route. To the eastern side a Simple T Junction is provided which will reconnect the existing N16 to the FRO;
- The route diverts offline once again, before entering *Castlegal (ED Glencar)* townland, where it intersects the L-7415-0, which will be reconnected via a Simple T Junction arrangement. Maintaining its general direction and having severed the existing N16, the route passes into *Lugatober* where it turns more north easterly severing local road L-7413-0, which will be reconnected via a staggered Right/Left Simple T Junction arrangement, in order to achieve direct access, this arrangement requires an alternative link access to the West;
- Maintaining direction, the route continues through *Lugatober*, before passing through *Collinsford* and *Lugnagall* townlands where the L-34041-0 and the L-3404-0 are respectively severed, the L-3404-0 is re-connected to the FRO via a Simple T Junction and the L-34041-0 is realigned to in turn connect to the L-3404-0;

- The route gradually changes to a more easterly direction as it enters the townland of *Gortnagrelly*, where it rejoins the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 7,880m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.9 Feasible Route Option 07

The FRO commences at the N16's junction with the N14/N15. Localised improvements which are yet to be determined, may be required within the Urban Area (this may include junction improvements and localised lane optimisation). The main physical element of the FRO, commences in the townland of *Ballytivnan*, at the centre point of the existing AbbVie Roundabout. The FRO will require consideration and potential improvement of the existing roundabout arrangement at this location:

- The FRO takes an easterly direction through *Rathbraghan* townland and into *Barroe* where it severs the existing N16, local connectivity will be maintained in this instance to the south via a Simple T Junction arrangement. The route gradually changes direction to a more northerly one, as it continues to pass through *Barroe*, before entering *Faughts* townland. It severs the L-3407-22 and then, via a staggered Right/Left Simple T Junction reconnects same within *Faughts* and *Doonally (ED Calry)* as it continues to travel north;
- The route severs local accesses while still in *Doonally (ED Calry),* before gradually changing to a north westerly direction and severing the existing N16 in the townland of *Doonally (ED Drumcliff East).* Maintaining this general direction, it intersects the existing N16 again in the townland of *Drumkilsellagh*, access is maintained in this instance via a staggered Right/Left Simple T Junction arrangement connecting the L-3406-0 to the West and the existing N16 to the East;
- The route diverts offline taking a northerly direction, for a short distance, before intersecting the existing N16 once again while still in the townland of *Drumkilsellagh*, it continues to sever and reconnect, via a Simple T Junction arrangement the L-7415-0, as it passes into *Castlegal (ED Glencar);*
- The route diverts offline in a north easterly direction and intersects the existing N16 again in the townland of *Lugatober;* access in this instance is maintained to the East via a Simple T Junction arrangement. The route continues to sever the L-7413-0 in *Lugatober*, and reconnect it to the West via a Simple T Junction arrangement, in addition a parallel link road is provided to the West which links a severed section of the existing N16 back into the L-7413-0 via a Simple T Junction arrangement;
- The route maintains a north easterly direction through *Lugatober*, before entering *Collinsford* and *Lugnagall*, where the L-34041-0 and the L-3404-0 are respectively severed. The L-34041-0 is reconnected, via an additional link and Simple T Junction back into the FRO, in turn the L-3404-0 is re-linked back into the L-34041-0 via a separate link arrangement;
- The route maintains its direction before entering *Gortnagrelly* townland and then gradually changes direction to a more easterly one, severing the L-7411-0 before rejoining the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,110m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.10 Feasible Route Option 08

The FRO commences at the N16's junction with the N14/N15. Localised improvements which are yet to be determined, may be required within the Urban Area (this may include junction improvements and localised lane optimisation). The main physical element of the FRO, commences in the townland of *Ballytivnan*, at the centre point of the existing AbbVie Roundabout. The FRO will require consideration and potential improvement of the existing roundabout arrangement at this location:

- The FRO takes a north easterly direction through *Rathbraghan* townland and into *Barroe* where it severs the existing N16, local connectivity will be maintained in this instance to the south and north via a staggered Right/Left Simple T Junction arrangement. The route gradually changes direction to a more northerly one, as it passes into *Faughts* townland. It severs the L-3407-22 and then, via a staggered Right/Left Simple T Junction reconnects same within *Faughts* as it continues to travel north into *Doonally (ED Calry)*;
- The route severs local accesses while still in *Doonally (ED Calry),* before gradually changing to a north westerly direction and severing the existing N16 in the townland of *Doonally (ED Drumcliff East).* Maintaining this general direction, it intersects the existing N16 again in the townland of *Drumkilsellagh*, access is maintained in this instance via a staggered Right/Left Simple T Junction arrangement connecting the L-3406-0 to the West and the existing N16 to the East;
- The route diverts offline taking a northerly direction, for a short distance, before intersecting the existing N16 once again while still in the townland of *Drumkilsellagh*, it continues to sever and reconnect, via a Simple T Junction arrangement the L-7415-0, as it passes into *Castlegal (ED Glencar);*
- The route diverts offline in a north easterly direction and intersects the existing N16 again in the townland of *Lugatober;* access in this instance is maintained to the East via a Simple T Junction arrangement. The route continues to sever the L-7413-0 in *Lugatober*, and reconnect it to the West via a Simple T Junction arrangement, in addition a parallel link road is provided to the West which links a severed section of the existing N16 back into the L-7413-0 via a Simple T Junction arrangement;
- The route maintains a north easterly direction through *Lugatober*, before entering *Collinsford* and *Lugnagall*, where the L-34041-0 and the L-3404-0 are respectively severed. The L-34041-0 is reconnected, via an additional link and Simple T Junction back into the FRO, in turn the L-3404-0 is re-linked back into the L-34041-0 via a separate link arrangement;
- The route maintains its direction before entering *Gortnagrelly* townland and then gradually changes direction to a more easterly one, severing the L-7411-0 before rejoining the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,130m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.11 Feasible Route Option 09

The FRO commences at the N16's junction with the N14/N15. Localised improvements which are yet to be determined, may be required within the Urban Area (this may include junction improvements and localised lane optimisation). The main physical element of the FRO, commences in the townland of *Ballytivnan*, at the centre point of the existing AbbVie Roundabout. The FRO will require consideration and potential improvement of the existing roundabout arrangement at this location:

- The FRO takes a north easterly direction through *Rathbraghan* townland and into *Barroe* where it severs the existing N16, local connectivity will be maintained in this instance to the south via a Simple T Junction arrangement. The route gradually changes direction to a more northerly one, as it continues to pass through *Barroe*, before entering *Faughts* townland. It severs the L-3407-22 and then, via a staggered Right/Left Simple T Junction reconnects same within *Faughts* and *Doonally (ED Calry)* as it continues to travel north;
- The route severs local accesses while still in *Doonally (ED Calry),* before gradually changing to a north westerly direction and serving the existing N16 in the townland of *Doonally (ED Drumcliff East).* Maintaining this general direction, it intersects the existing N16 again in the townland of *Drumkilsellagh*, access is maintained in this instance via a staggered Right/Left Simple T Junction arrangement connecting the L-3406-0 to the West and the existing N16 to the East;
- The route diverts offline taking a northerly direction, for a short distance, before intersecting the existing N16 once again while still in the townland of *Drumkilsellagh*, it continues to sever and reconnect, via a Simple T Junction arrangement the L-7415-0, as it passes into *Castlegal (ED Glencar);*
- The route diverts offline in a north easterly direction and intersects the existing N16 again in the townland of *Lugatober;* access in this instance is maintained to the East via a Simple T Junction arrangement. The route continues to sever the L-7413-0 in *Lugatober*, and reconnect it to the West via a Simple T Junction arrangement, in addition a parallel link road is provided to the West which links a severed section of the existing N16 back into the L-7413-0 via a Simple T Junction arrangement;
- The route maintains a north easterly direction through *Lugatober*, before entering *Collinsford* and *Lugnagall*, where the L-34041-0 and the L-3404-0 are respectively severed. The L-34041-0 is reconnected, via an additional link and Simple T Junction back into the FRO, in turn the L-3404-0 is re-linked back into the L-34041-0 via a separate link arrangement;
- The route maintains its direction before entering *Gortnagrelly* townland and then gradually changes direction to a more easterly one, severing the L-7411-0 before rejoining the existing N16 online. The severed section of the N16 to the south in this area is re-linked with a Simple T Junction arrangement;

The FRO generally continues online with minor deviation and widening before terminating at the County Boundary with Leitrim, a distance of circa 8,020m from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.12 Feasible Route Option 10

FRO 10 commences in the townland of *Rathbraghan*, strategically placed between the existing N15 to the West and the existing N16 to the East. The commencement point will be facilitated by a new

roundabout which will provide a National link to the N16 to the West and a local link to the N15 to the East.

- The N16 from its commencement point, progresses in a northerly direction before changing to a more north easterly one through the townland of *Rathbraghan*, where the local road L-7422-0 is severed to the East and reconnected to the West.
- It continues north easterly through the townlands of *Shannon Oughter* and *Carncash,* where it severs local road L-3407-0 to the West reconnecting it to the East. It continues through the townland of *Doonally (ED Drumcliff East),* before it rejoins the existing N16 online in the townland of *Drumkilsellagh,* a staggered right/left Simple T Junction is provided at this location to reconnect the L-3406-0 (Drum Road) and the existing N16 back into the FRO, additionally the existing N16 to the West is rejoined into the L-3406-0 via a parallel link road;
- The FRO stays online for circa 300m before it diverts offline to the north while still in the townland of *Drumkilsellagh*. Maintaining a generally northern direction, is severs and re-links the L-7415-0 back into the FRO in the townland of *Castlegal (ED Glencar)* before crossing the existing N16, followed by the L-7413-0 in the townland of *Lugatober*. The L-7413-0 is maintained via an underbridge while a parallel link road reconnects the existing N16 back into the L-7413-0;
- The route changes direction to a more north easterly one as it continues to pass through *Lugatober* townland. It severs the L-34041-0 and the L-3404-0 as it passes through *Collinsford* and *Lugnagall*. The L-3404-0 is re-linked back into the FRO via a realigned Simple T Junction arrangement, while the L-34041-0 is in turn linked into the realigned L-3404-0 via a similar junction arrangement;
- Maintaining its previous general direction, the FRO rejoins the existing N16 while still in the townland of *Lugnagall,* before it again diverts off to the north east in the townland of *Gortnagrelly.* The route remains to the south of the L-7411-0 before it again severs the existing N16 passing to its south. The existing N16 is re-linked back into the network via a staggered Right/Left Simple T Junction.

The FRO remains offline in an easterly direction before it intersects the county boundary where it terminates. If the route progresses to the 'Refined Number of Route Options' then an additional design and assessment within County Leitrim will be required. Its length at the intersection with the County Boundary is circa 8,220m measured from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.3.13 Feasible Route Option 11

FRO 11 commences in the townland of *Rathbraghan*, strategically placed between the existing N15 to the West and the existing N16 to the East. The commencement point will be facilitated by a new roundabout which will provide a National link to the N16 to the West and a local link to the N15 to the East.

- The N16 from its commencement point, progresses in a northerly direction before changing to a more north easterly one through the townland of *Rathbraghan*, where the local road L-7422-0 is severed to the East and reconnected to the West.
- It continues north easterly through the townlands of *Shannon Oughter* and *Carncash,* where it severs local road L-3407-0 to the West reconnecting it to the East. It continues through the townland of *Doonally (ED Drumcliff East),* before it rejoins the existing N16 online in the

townland of *Drumkilsellagh,* a staggered right/left Simple T Junction is provided at this location to reconnect the L-3406-0 (Drum Road) and the existing N16 back into the FRO, additionally the existing N16 to the West is rejoined into the L-3406-0 via a parallel link road;

- The FRO stays online for circa 300m before it diverts offline to the north while still in the townland of *Drumkilsellagh*. Maintaining a generally northern direction, is severs and re-links the L-7415-0 back into the FRO in the townland of *Castlegal (ED Glencar)* before crossing the existing N16, followed by the L-7413-0 in the townland of *Lugatober*. The L-7413-0 is maintained via an underbridge while a parallel link road reconnects the existing N16 back into the L-7413-0;
- The route changes direction to a more north easterly one as it continues to pass through *Lugatober* townland. It severs the L-34041-0 and the L-3404-0 as it passes through *Collinsford* and *Lugnagall*. The L-3404-0 is re-linked back into the FRO via a realigned Simple T Junction arrangement, while the L-34041-0 is in turn linked into the realigned L-3404-0 via a similar junction arrangement;
- Maintaining its previous general direction, the FRO rejoins the existing N16 while still in the townland of *Lugnagall,* before it again diverts off to the north east in the townland of *Gortnagrelly*. The route remains to the south of the L-7411-0 before it again severs the existing N16 passing to its south. The existing N16 is re-linked back into the network via a staggered Right/Left Simple T Junction.

The FRO remains offline to the north of the existing N16 and continues in an easterly direction before it intersects the county boundary where it terminates. If the route progresses to the 'Refined Number of Route Options' then an additional design and assessment within County Leitrim will be required. Its length at the intersection with the County Boundary is circa 8,220m measured from its physical commencement point at the existing AbbVie Roundabout, which is a further circa 1,900m from the existing N16's junction (Duck Street) with the N4/N15.

7.4 Public Consultation No. 02: Feasible Route Options

7.4.1 **Overview**

The 2nd Public Consultation for the Route Selection Process commenced on the 13th of January, 2016, with 2 open days/evenings in the Clarion Hotel, Sligo. The consultation period, extended to the 12th of February, during which time, submissions were requested from the Public. During this period, the design team were available to discuss and explain aspects of the Route Selection Process, to the Public.

In order to garner information, a questionnaire was prepared with the objective as outlined in Table 7-2.

Table 7-2: Extracted Text from the Questionnaire

...With cognisance of identified significant constraints, the Design Team have since established a number of 'Feasible Route Options'. *An assessment will now commence of these options, with the objective being to refine them down to a smaller number of viable options. The ultimate objective will be to establish the optimum route location, which may be, one of the current 'Feasible Route Options', or, an alternative amalgamation of a number of different routes. Additionally, further Routes may also be considered during this time.* *This process will enable prioritised sections (3 to 4km) of the route to be targeted for upgrading works over the coming years. In this regard, Sligo County Council wishes to consider all viewpoints in relation to the scheme. You are invited to give your opinions on the 'Feasible Route Options' by completing the*

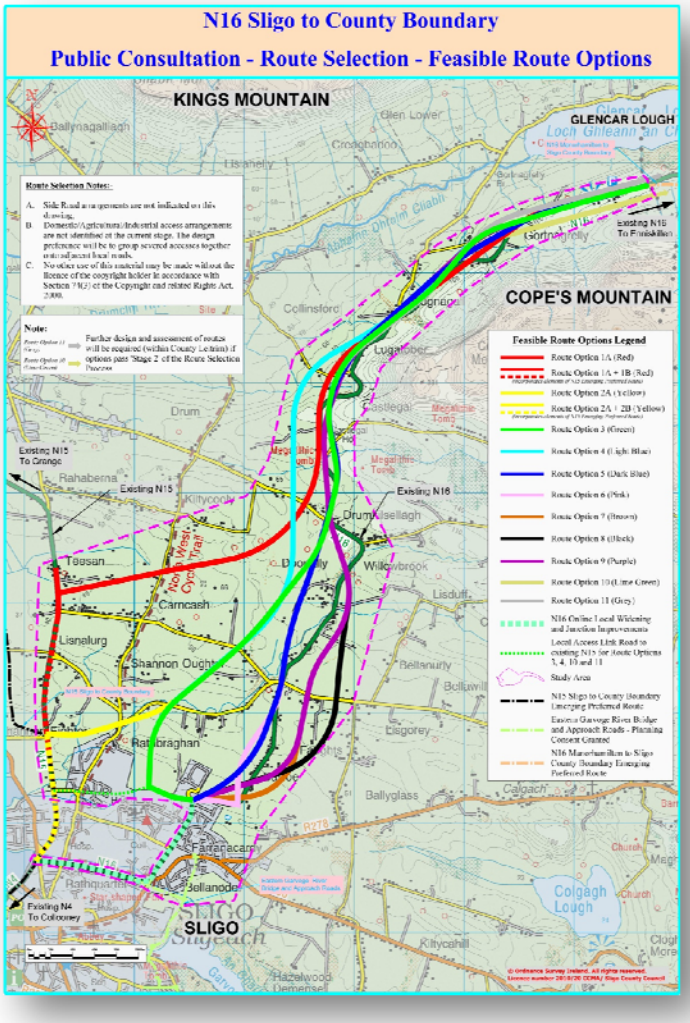
following questionnaire...

The methodology for collecting information within the questionnaire, was via a number of closed and open questions as outlined below:

(1) Is your property impacted by one of the Routes?
(2) If you answered 'Yes' to (1), please outline the relevant Route Number(s) and the townland location(s) if different to your address:
(3) Please specify the type of impact:
    a. Loss of Domestic Property;
    b. Potential new route is within 50m of Domestic Property;
    c. Potential new route is within 100m of Domestic Property;
    d. Severance of Agricultural Lands;
    e. Community Severance (i.e. the arrangement of the new road will impact on travel patterns);
    f. Other – To include Commercial, Industrial, Retail, or other property types;
    g. Other – Indirect Impact
(4) Please elaborate on the impact:
(5) Please provide some additional broad information in relation to your property, e.g. in the case of a Farm property this may include information on your general practice, i.e. Dairy, Dry Stock, etc. and stock numbers;
(6) Please rank the routes in order of your preference:
(7) In relation to Q6, Please specify the general reasons for your top marking Rank (Rank 1):
(8) In relation to Q6, Please specify the general reasons for your worst marking Rank (Rank 13):
(9) If you have any additional comments in relation to the Route Selection, or in relation to alternatives, please write them here:

A Route Selection Brochure was also prepared as part of this consultation period, outlining in general terms the Feasible Route Options (see Figure 7-1) and the Preliminary Options Assessment process.

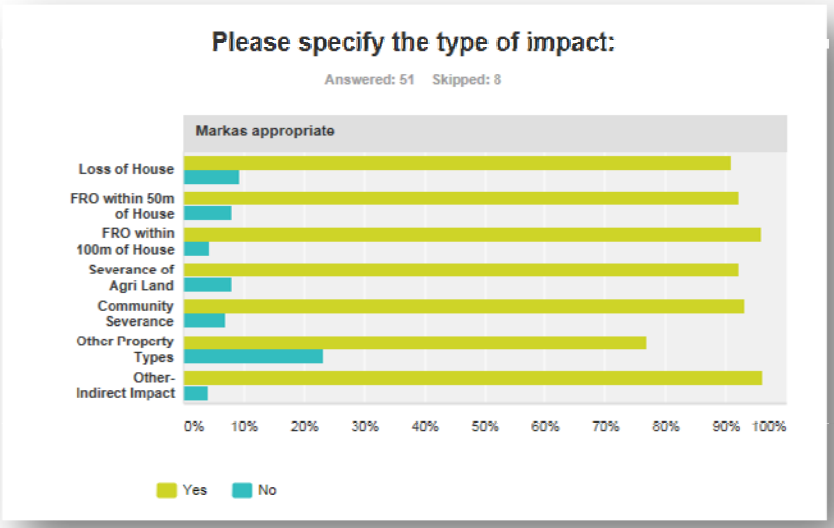
Figure 7-1: Overview Map of the Feasible Route Options



7.4.2 Submissions

In total, there were 63 submissions, of which 47 took the general form of the questions set out in the questionnaire, the balance of submissions were generally related to the severity of impacts, on particular properties. Each submission was examined and information, where made available, was used to inform the assessment process (e.g. Socio Economic, Agricultural and Non-Agricultural Property). Of the submissions made, 90% related to property, or community impacts (see Figure 7-2).

Figure 7-2: Summary of Impact Types



The majority of impacts related to those which were particular to individual properties, or communities. In this regard and in consideration of the fact that various disciplines take these matters into account during the Preliminary Options Assessment (e.g. Socio Economic considers community severance in a general sense and Agricultural/Non-Agricultural Property impacts considers impacts on property), it was considered inappropriate to directly include the opinions of the public in the Preliminary Options Assessment. However, each submission has been made available to the various specialists and where appropriate consideration has been had to impacts in the various studies, additionally the submissions made, allowed the design team to gain an appreciation of where various sensitivities occur and to consider design mitigation measures where these are achievable.

Notwithstanding the foregoing, section 7.4.3 provides an overview of the general public perception in relation to the Feasible Route Options.

7.4.3 Public Preference

As already outlined in section 7.4.1, the public were requested as part of the questionnaire, to outline their various route preferences. Figure 7-3 outlines in percentage terms, those which were considered to be most preferred (a rank of '1' or '2'), while Figure 7-4 outlines in percentage terms, those which were considered to be least preferred (a rank of '12' or '13'). In general, contrasting results are visible with options 01A, 01A/B, 2A, 2A/B and 05 generally receiving most attention for varying reasons.

In terms of most preferred, a preference is generally observant with regards in particular, to options 01A, 05 and 01A/B. However, this must be balanced against those which are considered least preferred, including in particular options 01A, 01A/B, 02A and 02A/B.

As part of answers to these particular questions, the public were also asked to outline why best and worst ranks were attributed to different routes. These reasons were reviewed and summarised into different headings to simplify in reporting terms, the general overall feeling of the public. Table 7-3 outlines the reasons for the best ranking options, while Table 7-4 outlines the reasons for the worst ranking options.

Figure 7-3: Overview of Public Preference – Sum of '1' and '2'; Best Option Ranks

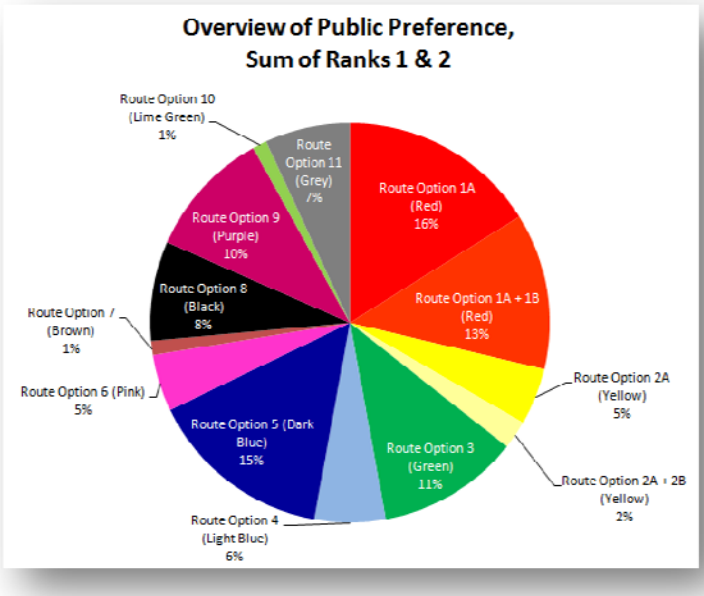


Figure 7-4: Overview of Public Preference – Sum of '12' and '13' Ranks; Worst Option Ranks

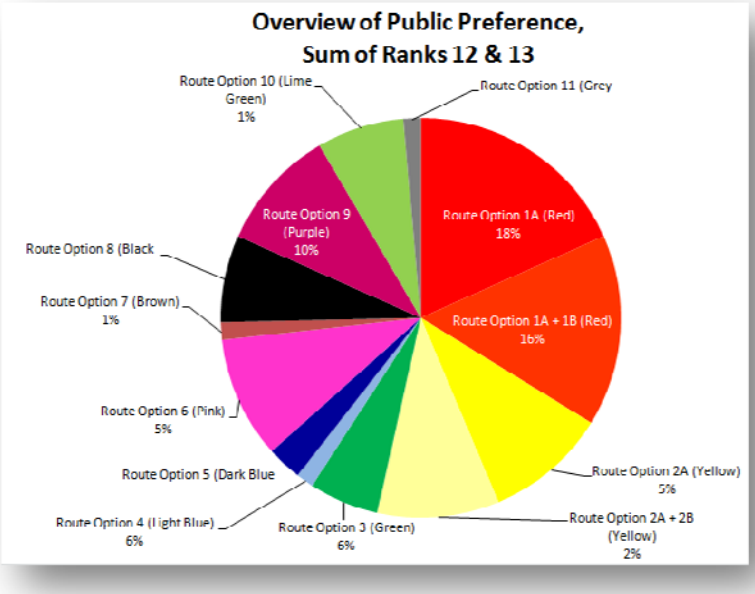


Table 7-3: Reasons for Top Marking Rank

Route	Reasons for High preference
1A & 1A/1B	Avoids notable property Impacts
	Avoids notable property Impacts and a possible good point of entry to Sligo City.

Route	Reasons for High preference
	Good strategic entry point to Sligo
	Good point of entry to Sligo – removing heavy traffic from the Bellanode Area.
	Good strategic Route, avoids notable property Impacts and removes heavy traffic from the Bellanode Area
2A & 2A/2B	Connects transport with a more appropriate national route.
	Good point of entry to Sligo and allows for improved development potential
	Good point of entry to Sligo.
3	Good point of entry to Sligo.
4	Avoids notable property Impacts
	Good point of entry to Sligo.
5	Avoids notable property Impacts (particular property)
	Most direct route and avoids notable property Impacts
	Maintains the current alignment
	The ground conditions are more suitable for road construction
7	Avoids notable property Impacts (particular property)
8	Avoids congestion on Hughes Bridge
9	Avoids congestion on Hughes Bridge
	Avoids notable property Impacts
	Avoids notable property Impacts (particular property)
	Less environmental impact on the landscape.
	Less visual and property Impacts
	Maintains the current alignment
11	Avoids notable property Impacts (particular property)

Table 7-4: Reasons for Worst Marking Rank

Route	Reasons for Low Preference
1A & 1A/B	Does not utilise the future relief which the Eastern Garvogue Bridge will provide.
	Increases N15 traffic level and results in notable property impacts on the N15
	Impacts on the North West Cycle Trail;
	Notable impacts on a particular property.
	Notable impacts on a particular property (agri.).
	Notable impacts on other family members property.
	Notable impacts on community severance.
	Notable Visual impacts.
	Notable biodiversity impacts.

Route	Reasons for Low Preference
	Not a direct route for Sligo traffic.
2A & 2A/B	Increases N15 traffic level;
	Does not utilise the future relief which the Eastern Garvogue Bridge will provide.
	Notable impacts on a particular property.
	Notable impacts on a particular property (agri.).
	Notable impacts on community severance.
	Notable Visual impacts.
	Will lead to increased suburbanization of rural landscape.
	Notable impacts on a walking trail.
3	Notable impacts on the future expansion of Sligo
3, 4, 10, 11	Notable impacts on a particular property;
	Impacts on future expansion of development.
5	Notable impacts on a particular property.
6	Not a good alignment.
5, 6	Notable impacts on a particular property (agri).
5, 6, 7, 8, 9	Notable traffic congestion impacts on a particular industrial property.
7 & 9	Notable impacts on a particular property.
7, 8, 9	Notable impacts on a particular property (agri.).
8, 9	Notable impacts on a particular property.
9	Will increase traffic saturation levels on the N16 in the Urban Area.
	Notable impacts on a particular property (agri.).
	Notable impacts on community severance.
10	Notable impacts on a particular property.
	Notable ecological impacts and potential for landslides

7.4.4 Statutory and Non-Statutory Bodies

The following statutory and non-statutory bodies were written to as part of the 02nd Consultation process. The correspondence issued, provided a brief overview of the Route Selection process together with a map (as per Figure 7-1) showing the Feasible Route Options.

- Commissioner of Public Works in Ireland;
- Fáilte Ireland;
- An Taisce- The National Trust for Ireland;
- The Arts Council/An Chomhairle Ealaíon;
- The Heritage Council;
- Inland Fisheries Ireland;

- Córas Iompair Éireann;
- National Roads Authority;
- Údarás na Gaeltachta;
- Environmental Protection Agency;
- Department of Communications, Energy and Natural Resources;
- Department of Arts, Heritage and the Gaeltacht;
- Minister for the Environment, Community and Local Government;
- Irish Aviation Authority;
- Border Midlands and West Regional Assembly;
- National Parks and Wildlife Service;
- Health Services Executive;
- Minister for Justice and Equality;
- Electricity Supply Board;
- Irish Central Border Area Network (ICBAN) Ltd.;
- Leitrim County Council;

Observations (included in section **Error! Reference source not found.** of this Report) were received during this process from the following bodies:

- ESB Networks;
- Inland Fisheries Ireland;
- Geological Survey of Ireland - Department of Communications, Energy, and Natural Resources; and
- Irish Water.

vi. Stage 1: Preliminary Options Assessment

8 Traffic & Transport Assessment[59]

8.1 Introduction

The Traffic and Transport Assessment element of the Route Selection Report was carried out by Jacobs Engineering on behalf of the Sligo National Roads Project Office. The assessment which constituted the development of a detailed Traffic Model was undertaken over three separate stages in order to assist in the refinement of Route Options. The results of these key stages are documented within the following reports which are embedded within Volume 2, Part A, of the Route Selection Report:

- N16 Traffic Modelling – Interim Technical Note issued in May 2016;
- N16 Key Performance Indicator Testing Technical Note (December 2016);
- N16 Key Performance Indicator Sensitivity Testing Technical Note (January 2017); and
- N16 Route Selection Study, Final Report, May 2017

The purpose of this Chapter is to provide an overview in relation to the construction of the Traffic and Transport Assessment model. The options assessment pertaining to same, is summarised in section 9.3.1 (Stage 1, Part 1 – Preliminary Options Assessment), 10.3.1 (Stage 1, Part 2 – Preliminary Options Assessment) and 11.3.2 (Stage 2, Project Appraisal) of the Route Selection Report.

The aforementioned reports should be referred to, for a more detailed appreciation in relation to the assessment. The following sections of this Chapter are generally extracted from the aforementioned 'Final Report'.

Given the complexity associated with traffic modelling assessment and the similarities associated with some route options, it was not considered appropriate to model each individual route option previously described in section 6.5.3.4. Table 8-1, Table 8-2 and Table 8-3 outline the Feasible Route Options which were modelled. This is in addition to the 'Do-Nothing' and 'Do-Minimum' scenarios.

Table 8-1: Stage 1, Part 1, Preliminary Options Assessment

Strategic Option	Option Modelled	Feasible Route Options
Strategic Option 1	Option 01A	Option 01A
	Option 01A/01B	Option 01A/01B
Strategic Option 2	Option 02A	Option 02A
	Option 02A/02B	Option 02A/02B
Strategic Option 3	Option 03	Option 03
		Option 04
		Option 10
		Option 11
Strategic Option 4	Option 05	Option 05
	Option 06	Option 06

[59] 'Copyright' and 'Limitations' inscribed in the accompanied reports within Volume 2, Part A should be noted.

Strategic Option	Option Modelled	Feasible Route Options
	Option 08	Option 07
		Option 08
		Option 09

Table 8-2: Stage 1, Part 2, Preliminary Options Assessment

Strategic Option	Option Modelled	Refined 'Feasible Route Options'
Strategic Option 1	Option 01A-v2	Option 01A-v2
	Option 01A/01B-v2	Option 01A/01B-v2
Strategic Option 2	Option 02A-v2	Option 02A-v2
	Option 02A/02B-v2	Option 02A/02B-v2
Strategic Option 4	Option 05	Option 05
	Option 08	Option 08-v2
		Option 12
		Option 12-v2

Table 8-3: Traffic Modelling Test 3 – Stage 2, Project Appraisal

Strategic Option	Option Modelled	Refined Route Options
Strategic Option 1	Option 01A-v2	Option 01A-v2
Strategic Option 4	Option 05	Option 05
	Option 12	Option 12

8.2 Methodology

8.2.1 **Modelling Approach**

The proposed scheme was modelled using the macro modelling software SATURN. This modelling was undertaken through the uplift of available existing base model networks. Available base matrices were uplifted using TII's National Transport Model (NTpM).

Using previous base network and matrices from 2009 developed for the N15 Realignment, the 2015 base SATURN macro model was tailored and uplifted to suit the requirements of the proposed scheme in terms of size and scope and to reflect some software advances. The 2015 model still includes detail of the area surrounding the Sligo urban area, identifying wider urban and regional impacts of the proposed scheme.

The following section provides a more comprehensive overview of the existing Sligo SATURN model.

8.2.1.1 2009 SATURN Model

The 2009 Base Model, developed using SATURN Version 10.5.12, was built in order to model proposed options, forecast traffic volumes and undertake economic appraisal of the proposed N15

Sligo-County Boundary Realignment project between Sligo City and the Leitrim border east of *Mullaghmore*.

This model was built by Ryan Hanley WSP/Colin Buchanan and featured 221 nodes and 82 zones. It was a simulation-type network in its entirety, i.e. with no buffer network area. Figure 8-1 shows the extents of the 2009 Base SATURN Model which extends to the Sligo-Leitrim County Border.

The speed-flow relationship used in the 2009 base model was developed using the Irish COBA software package. Speed-flow curves used for the links in this model were grouped into eleven categories with each assigned a speed-flow curve from COBA. Due to differences between COBA equations and those used in SATURN, regression analysis was used in order to estimate the best fit curves for use in the model.

This model featured three time periods: AM, Interpeak (IP) and PM. For both the AM and PM periods a onehour peak was modelled: 08:00 – 09:00 and 17:00 – 18:00 respectively. For the IP period an average interpeak hour was used.

Traffic data including turning movement counts (manual classified counts), queue length surveys and journey time surveys were undertaken throughout Sligo City and the N15 Sligo City to Sligo / Leitrim county boundary area. This data, dated September 2005 and May/June 2009, was used to replicate traffic flows in the study area. These surveys were also used during the Matrix Estimation, Calibration and Validation phases of the 2009 base model build.

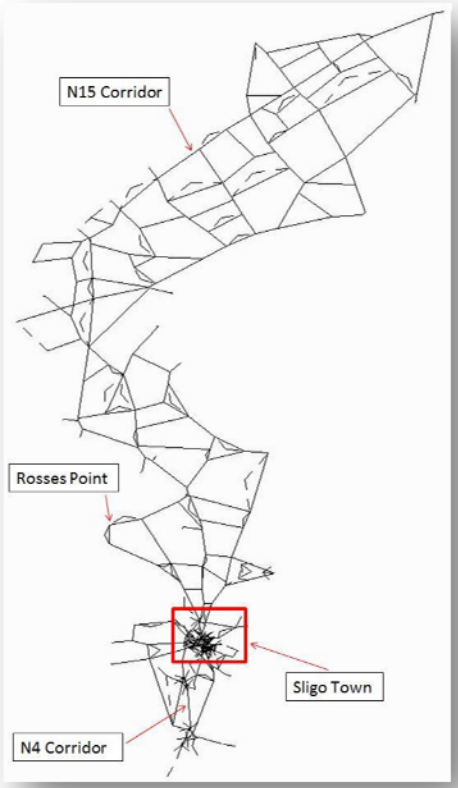
The demand matrices used for the 2009 Base Model were developed and based on a series of Roadside Interviews carried out in September 2005. This information had been processed into appropriate formats to aid matrix development and there were two category matrices in the 2009 base: Light Vehicles and Heavy Vehicles.

Network calibration and validation of the base model was undertaken to observed traffic data. The following criteria outlined in TII's Design Manual for Roads and Bridges (DMRB) were used for calibration:

(1) For observed flows of less than 700 Passenger Car Units (PCU), the absolute difference between modelled and observed flow must be less than 100 PCU. For flows between 700 and 2,700 PCU, the absolute percentage difference must be less than 15%, while for observed flows of more than 2,700 PCU, the absolute difference can be as much as 400 PCU. The DMRB states that at least 85% of count sites should pass the percentage difference of 15%;

(2) The second criterion for assessing the goodness of fit of a model is the calculation of the GEH value for each observed value. The DMRB states that at least 85% of count sites should pass the percentage difference of 15%.

Figure 8-1: 2009 Base SATURN Model



8.2.1.2 Update SATURN Macro Model

A comprehensive macro model using SATURN was generated through the uplift of the existing traffic demand and extension of its road network. The 2009 base SATURN model was uplifted to 2015 levels in order to model and forecast the impact of the proposed scheme. The 2009 base network was cordoned along the N15 corridor to remove excess network detail.

Existing demand matrices were revised according to network changes made. This included the removal of zones now redundant following the cordoning of the 2009 base network. These matrices were also uplifted to 2015 levels using indices from TII's NTpM.

Where required, new features available in more recent versions of SATURN were used to enhance network performance.

8.2.1.3 Model Extents

Figure 8-2 outlines the outer boundary of the extents of the SATURN model used for the proposed scheme. This illustration shows the extents of the overall SATURN model network and the existing N16 alignment.

8.2.1.4 Summary of Changes to the Sligo Models

Table 8-4 outlines the overall changes undertaken for the 2015 SATURN Model uplift.

Table 8-4: Summary of Changes to Saturn Model

Item	2009 Base Model	2015 Base Model
SATURN version	10.5.12	11.3.03G
Base year	2009	2015
Zoning	82 zones	63 zones
Simulation / Buffer Area	All Simulation, No Buffer	All Simulation, No Buffer
Use of Flare Coding Functions	Not available in Version 10.5.12	Flares coded along N4 Inner Relief Road
Network Extents	Comprehensive detail along N15 corridor to Leitrim Boundary	N15 cordoned at Cashelgarran Additional detail provided along N16 corridor to the Leitrim Boundary

Figure 8-2: Extents of Saturn Model

8.3 Traffic Data Collection

8.3.1 Background

In order to calibrate and validate the model to existing base conditions, appropriate levels of up-to-date traffic count information was required. This information included Junction Turning Counts at key junctions, Automatic Traffic Counts, Journey Time Routes and Queue Length Surveys. It was crucial that the data used in the model's development was gathered during a period which was deemed to be neutral and avoided school holidays, periods of road works, extreme weather events, protests/strikes, road traffic accidents, traffic signal failure and any other events which may have compromised the gathered data being representative of typical traffic levels.

8.3.2 Review of Existing Data Sources

In order to scope out the level of traffic surveys required, a gap analysis was carried out in the context of the traffic data already available. This gap analysis was carried out in the context of data available in the study area from TII's permanent traffic counters and the National Transport Authority's (NTA) Traffic Count Database. This gap analysis reviewed data available from TII and the NTA, and the appropriateness of data available from each source with a view to reducing the net amount of locations required for data procurement.

8.3.3 TII Traffic Monitoring Unit Online Data Portal

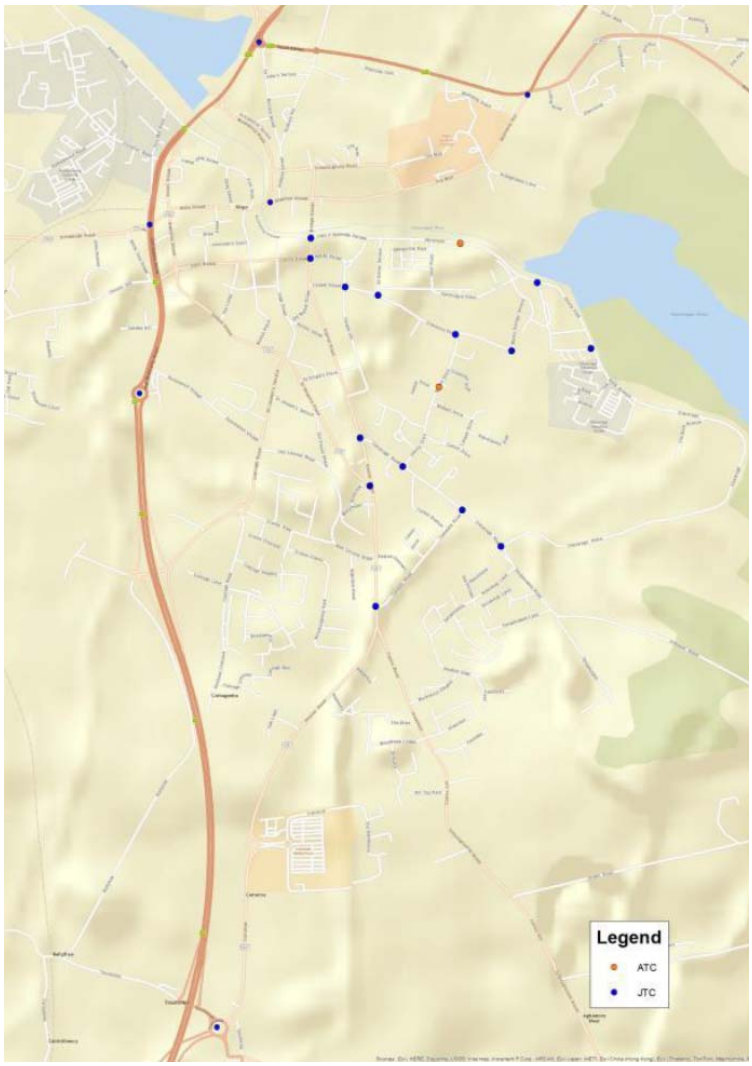
TII's online traffic data portal was used to identify existing permanent induction loops in and around the study network for which comprehensive, year-round traffic data was available. Unfortunately only one site was available, located along the N4 mainline just north of the N59 junction, south of Sligo. This data source was very useful as it contained detailed up to date information.

8.3.4 NTA National Traffic Count Database

The NTA has recently developed a Traffic Count Database. Unlike the TII system, this database stores historical traffic count information gathered in temporary traffic surveys. This data pool was developed during a request made by the NTA to local authorities nationwide for available datasets. Originally developed for the NTA's Regional Transport Models, this data pool was developed into an online interactive dataset repository for the use of local authorities nationwide to aid and assist their infrastructural projects. Locations for which data was available from the NTA in the study area before surveys were commissioned are outlined in Figure 8-3.

The 22 available datasets for the study area were reviewed in the first instance. Following this analysis, further traffic surveys were commissioned in order to fulfil the modelling requirements of the proposed scheme.

Figure 8-3: NTA Traffic Count Database - Availability in Sligo



8.3.5 New Survey Data Requirements

Following the gap analysis of the existing survey data, additional survey requirements were identified and agreed with the design team, based primarily on the modelling requirements for the proposed scheme. Junction Turning Counts, Pedestrian Counts, Automatic Traffic Counts and Journey Time Surveys were undertaken across Sligo City and the surrounding area. These surveys were undertaken as follows:

- Junction Turning Counts: 43 locations for a 12 hour period (07:00 – 19:00);
- Pedestrian Surveys: 30 locations for a 12 hour period (07:00 – 19:00);
- Automatic Traffic Counts: 17 Locations for a 2 week period; 2 locations for a 24 hour period;
- Journey Time Surveys: 8 Bi-directional routes undertaken a minimum of 8 times during each time period.

The final specification of locations identified for traffic surveys by Tracsis is outlined spatially in a regional and urban context in Figure 8-4 and Figure 8-5. These locations and types are outlined in further detail in Section 8.3.6 to 8.3.9.

Figure 8-4: Regional Data Collection Locations

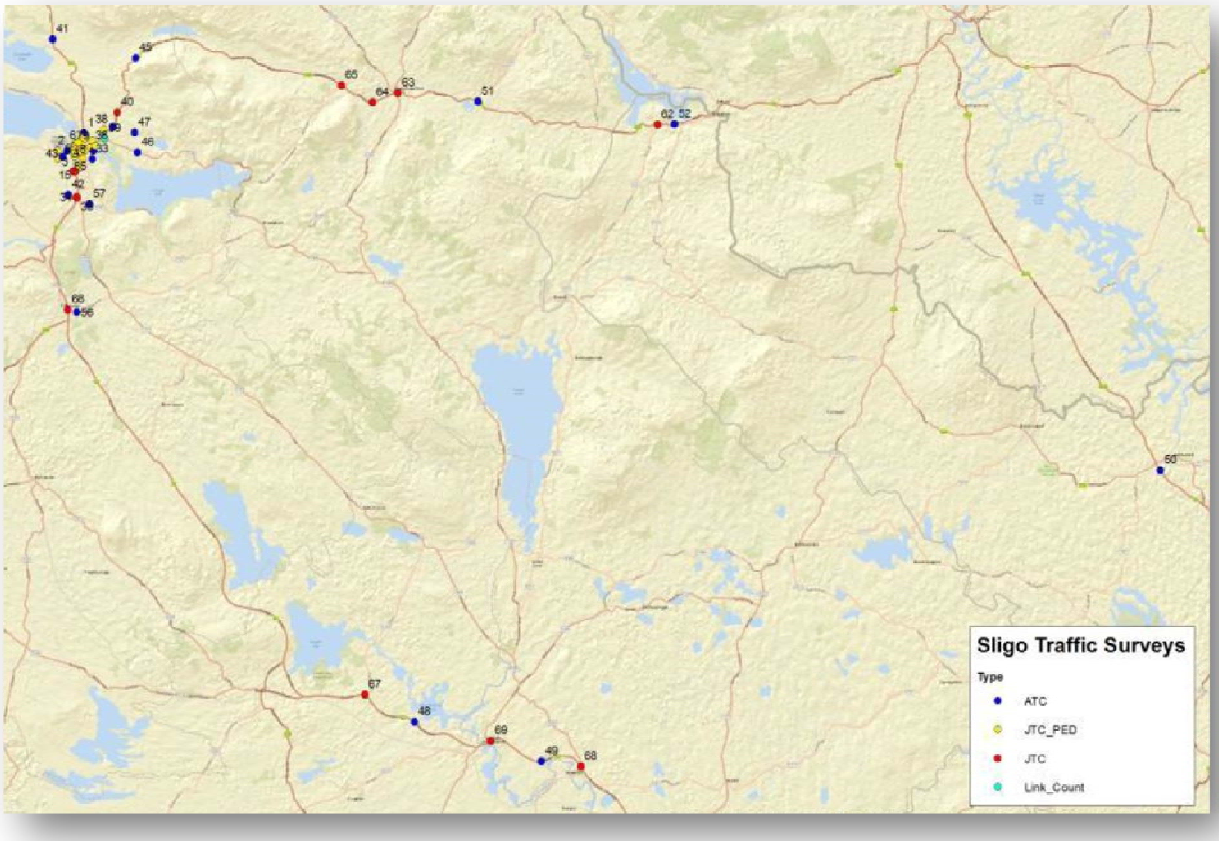
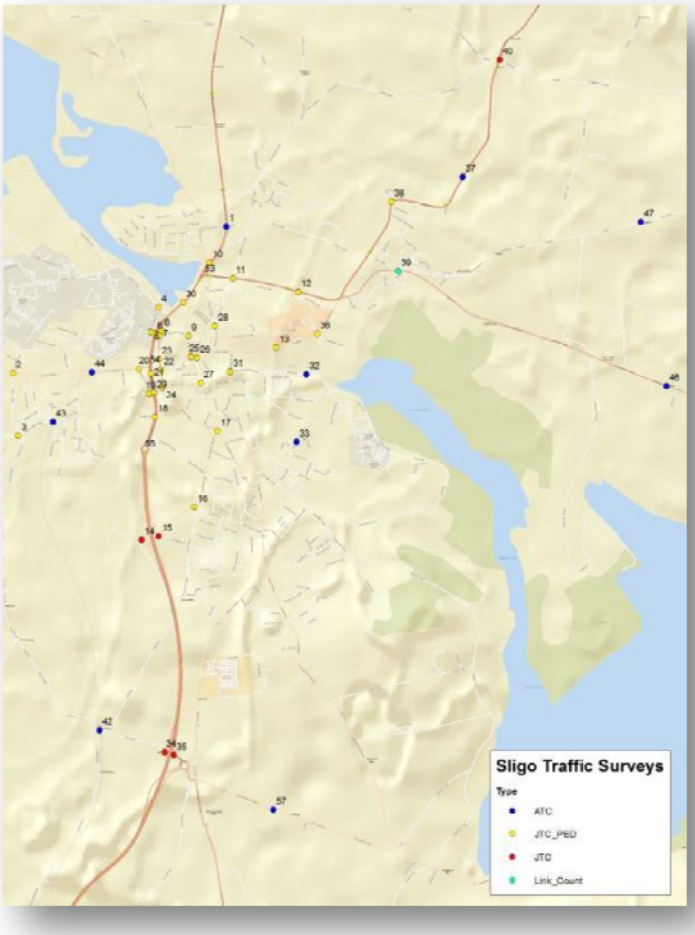


Figure 8-5: Sligo Urban Area Data Collection Locations



8.3.6 Junction Turning Counts

A number of 24-hour Junction Turning Count (JTC) surveys were undertaken at junctions identified in Figure 8-4 and Figure 8-5. The collection of the stratified individual turning movements typical of this type of surveying, provided a comprehensive level of detail with which to calibrate the traffic model, this is particularly beneficial in a model with a detailed central urban area such as Sligo City. JTC surveys were undertaken on 22nd September 2015. A small number of these were repeated on the 22nd October due to minor localised traffic implications.

The sites identified for JTC surveys were based not only upon model requirements for the proposed scheme, but also with a view to ascertaining any cross-country flow along regional roads in the wider regional area.

8.3.7 Pedestrian Counts

Pedestrian surveys were undertaken within the central areas of the model network, predominantly around Sligo City, at key locations of heavy pedestrian traffic. Pedestrian data was always recorded concurrent with the execution of a JTC, although not every junction surveyed by JTC had pedestrian data collected. Data was collected for pedestrian movements across each arm of the locations in Figure 8-5. These surveys were also undertaken on 22nd September 2015.

8.3.8 Automatic Traffic Counts

Automatic Traffic Counts (ATC), using pneumatic tube counting equipment, were used for the calibration of the model. The sites identified for ATC surveys were based not only upon model requirements for the proposed scheme, but also with a view to ascertaining any cross-country flow along regional roads in the wider regional area. ATC sites surveyed are identified in Figure 8-4 and Figure 8-5 and were carried out over a two-week period starting 21st September 2015, providing a robust, comprehensive dataset.

A small number of locations identified for ATC survey were captured by a 'link count' type survey. Link count surveys were undertaken using camera equipment and were undertaken in certain locations where an ATC was not feasible or appropriate due to operational reasons or pedestrian safety. They also gathered classified bidirectional traffic flow along specified links. These were executed for a 24 hour period rather than two weeks.

To supplement the outputs from the aforementioned ATC surveys, data readily available from the TII permanent counter on the N4 between the N59 junction and Carrowroe junction was used.

8.3.9 Journey Time Routes

Journey Time Data, replicating congestion and delays within the network area, were gathered for the validation of the model. Four bi-directional routes, were strategically selected for validation purposes. The selected routes included movements along the existing N16 between the Leitrim County Boundary and the AbbVie Roundabout, key arterial routes, throughout the city centre, and over bridge crossings of the Garvogue River.

The Garvogue River was a key screenline in the study area. Crossing points along the river are central to the network's performance and were required to be adequately represented in Journey Time Surveys. The journey time routes selected ensured that:

- The N4-N15 corridor was adequately represented including key turning movements
- City Centre traffic was adequately represented
- Crossing points on the River Garavogue screenline were adequately represented

Journey time information was gathered for the identified routes for the following time periods:

- AM (07:00 – 10:00);
- Interpeak (11:00 – 15:00);
- PM (16:00 – 19:00)

Between 8 and 14 runs were undertaken on each route per time period, depending on the particular length of the route and specific time period. More runs were achieved during the Interpeak due to the larger time range involved. These were undertaken on either the 22nd September 2015 or the 20th October 2015.

8.4 Sligo SATURN Network Development

This section outlines the updating and the development of the Sligo SATURN model road network. SATURN software version 11.3.03G was used for this modelling exercise. The base year network was coded as 2015 and network wide improvements/upgrades that were carried out on the ground since the 2009 base model were included in the network update.

8.4.1 Modelled Periods

Similar to the original model three different base models have been used as part of this study: AM, Interpeak (IP) and PM. The road network is the same across all three models with the only difference being signal timings and observed traffic data. For both the AM and PM periods a one hour peak was modelled: 08:00 – 09:00 and 17:00 – 18:00 respectively, both periods corresponding to the periods of peak flow across the network. For the IP Period an average Interpeak hour was used.

Section 3.5 of Unit 5.1 in the TII PAG outlines the inclusion of these three periods is recommended so the model is representative of different time periods during the day and the associated tidal flows *'in order to facilitate an accurate cost benefit appraisal'*.

8.4.2 2015 SATURN Network

8.4.2.1 Network Extents

A visual schematic of the previous base network (2009) supplied to Jacobs is outlined in Figure 8-6. This model was developed primarily for the purposes of the realignment of the N15 National Primary Route between Sligo City and the County Boundary with Leitrim. Consequently a significant amount of detail of local and regional roads within the Study Area Corridor was included in that base network. The following is an outline of how the 2009 Base Model was tailored for the needs of the proposed scheme.

The previous 2009 base network was cordoned in the vicinity of the townland of *Cashelgarran*, west of Benbulben Mountain along the N15 route corridor. It was concluded that the level of network detail along the N15 corridor north of this point was not appropriate to be included in the updated 2015 Base Model due to its distance from the proposed scheme study area and the likely area of influence of the scheme. Network detail in this particular area was developed in the 2009 base network primarily for the N15 realignment. Figure 8-6 shows the 2009 base network including the point at which it was cordoned. Network detail north of this point was removed.

The new network detail required in the 2015 update includes the Clarion Road, AbbVie Roundabout, the N16 to the Leitrim Boundary, and local road connections to the N16. Figure 8-7 illustrates the additional network extents coded in the 2015 base model.

Figure 8-6: 2009 Base Network with Cordoning Point

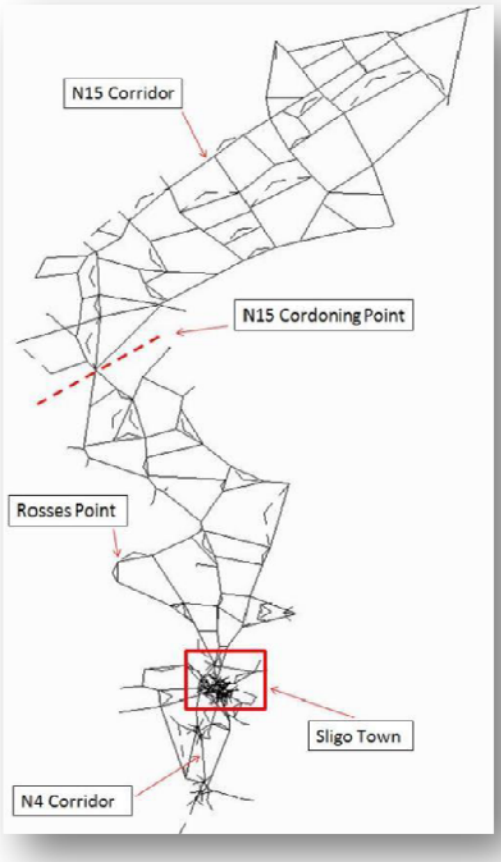
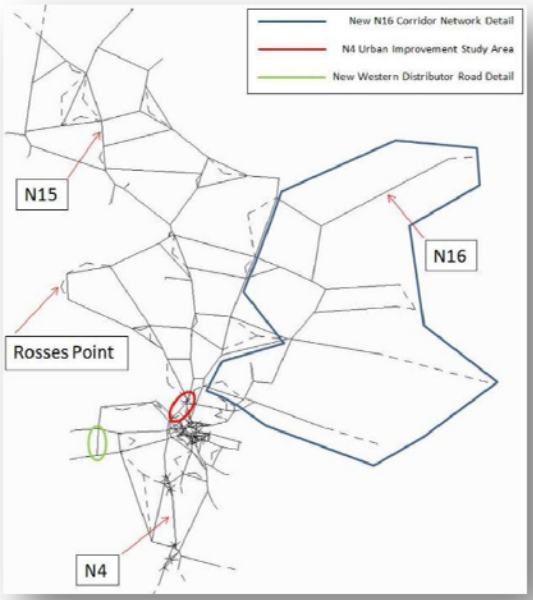


Figure 8-7: 2015 Base Model



8.4.2.2 Network Coding

In addition to cordoning and extending the model to meet the requirements of the proposed scheme assessment, there were significant on-site network changes introduced since the previous model was developed in 2009. These network changes were required to be included in the 2015 base model.

The following is a list of network changes made in the Sligo Urban Area to the 2009 base model by Jacobs to refresh the simulation network to the 2015 baseline:

1. O'Connell Street de-pedestrianised: This link was included in the model with one lane northbound with right turn only onto Hyde Bridge;
2. Section of Western Distributor Road: (Ballydoogan Rd - Strandhill Rd), circled in green in Figure 8-7;
3. Markievicz Road/Stephen Road/Hyde Bridge: Bridge approach and Stephen Street approach to junction narrowed to 1 lane each;
4. Right turn from Fish Quay to Wine Street: is coded in existing base model. Right Turn movement barred;
5. Barred Right Turn: from Union Street to Lord Edward Street;
6. Barrack Street movement restrictions: at northern end junction with N4/N15/N16 (central reservation at end of N16; and
7. Hughes Bridge widening: three lanes southbound, two lanes northbound.

SATURN version 11.3.3 provides the capability to code and model short turning lanes in greater detail than previously, through the use of '*flares*'. This new feature is a more recent addition to the SATURN software, and allows shorter turning lanes to be coded into the SATURN network with a stacking length in a number of PCUs. This feature more accurately simulates shorter left or right turning lanes at the stop lines of junctions where the road on the ground widens at the end of a link. Flares were coded at junctions along the N4 within Sligo City to better represent the network detail in the proposed scheme study area.

8.4.2.3 Saturation Flows

The 2009 base model saturation flows were calculated from geometric parameters including turning radii and lane widths measured from OSi mapping. The model was subsequently calibrated. As such, the saturation flows in the original 2009 network coding have not been amended in the 2015 update.

8.4.2.4 Speed Flow Curves

Speed-flow curves influence how many vehicles use each link in a modelled network. The 2009 base network featured speed flow curves assigned from the COBA manual. These speed flow curves were retained in the 2015 base network update.

8.4.2.5 Zone System

The development of the 2015 base network detail resulted in an overall reduction in numbers of zones over the zonal system in the 2009 base network. The 2009 base network featured a total of 82 zones. The first step required in using this model was to cordon out the extents along the N15 corridor to remove excess network detail beyond the area of influence of the proposed N4 and N16 schemes. This cordoning exercise removed 27 zones from the 2009 network (29 – 54, 82) however this exercise derived two new cordon point zones in the N15 corridor, 201 and 202. Their location is outlined in Figure 8-8. This net reduction of 25 zones reduced the cordoned network to 57 zones.

Following these amendments, new zones were added and some were relocated in conjunction with network update and expansion.

In the 2009 base network the extent of the network detail north east of Sligo City ended northeast of the N16 / R286 Ash Lane Junction. Zones 65 and 66 were located just north and west of the N16/R286 Ash Lane Junction along the N16 and R286 respectively. Due to the expansion of the network extents in a northwest direction along the N16 corridor from this point, zones 65 and 66 were retained in the updated model network but were relocated to new edge of network locations on the respective roads (N16 and R286 respectively). The new locations for zonal centroids of 65 and 66 are identified in Figure 8-8.

The update of the model to include infrastructural modifications that had occurred on the ground since 2009, and key trip generators in and around the new N16 corridor network detail in the road network on the ground, resulted in the creation of zones 100, 101, 102, 103, 104 and 203 at locations including Clarion Hotel, IT Sligo, Abbvie at AbbVie roundabout, local roads adjacent to the N16 corridor and Cairns Road in the Southeast of the city. The addition of these six new zones brought the final number of zones to 63. The locations of all new zones added to the 2015 base network are outlined in Figure 8-8.

Small additional features of network coding, such as the inclusion of a small section of the Western Distributor Road and the de-pedestrianisation of O'Connell Street were connected to nearby zones existing form the 2009 base network whose locations were not changed. Table 8-5 summarises all additional and relocated node centroids.

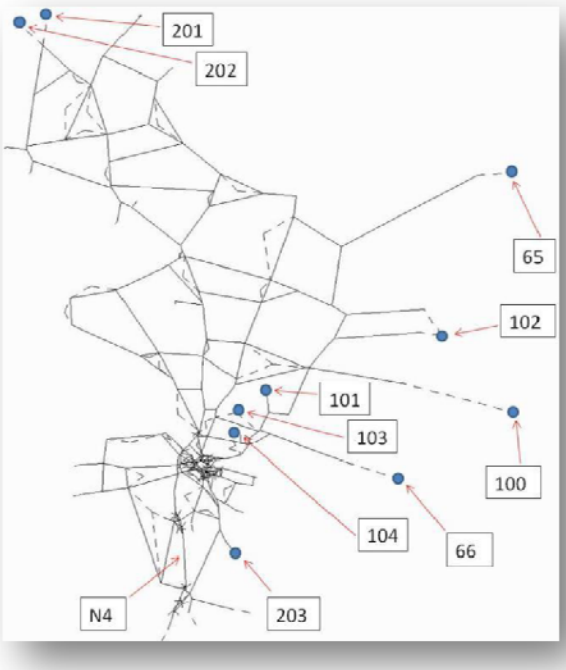
Table 8-5: Centroid Zonal Changes/Additions

Zone No.	Road / Development	Status
65	N16	Relocated to Sligo / Leitrim boundary following extension of network for N16 corridor area
66	R286	Relocated further along R286 following extension of network for N16 corridor area
100	R278	New zone east of N16 following extension of network for N16 corridor area
101	AbbVie Development	New zone for Abbvie at Abbvie Roundabout following extension of network for N16 corridor area
102	Local Road – Carrowlustia / Lisduff Townland	New zone east of N16 following extension of network for N16 corridor area
103	Clarion hotel and adjacent development	New zone for Clarion Hotel following inclusion of Clarion Road for extension of network for N16 corridor
104	Sligo IT	New zone for IT Sligo following extension of network for N16 corridor area
201	Local Road -Cashelgarran	New zone derived from the reduction of N15 corridor at the point of cordon
202	N15	New zone derived from the reduction of N15 corridor at the point of cordon
203	Cairns Road	New zone on Cairns Road to facilitate the inclusion of the Cairns Road / Pearse Road Junction

8.4.3 Summary

The 2009 SATURN model road network and zone system were updated to meet the requirements of the proposed scheme assessment. This included cordoning out unnecessary network, extending the boundary to include the N16, providing greater detail on the N4 and updating the zone system.

Figure 8-8: 2015 Base Network Centroid Additions/Relocations - Centroids



8.5 SATURN Demand Matrix Development

8.5.1 Prior Matrices

The development of prior matrices was undertaken from two separate sources:

- Sligo SATURN Model 2009 Base Matrices; and
- TII National Transport Model (NTpM) 2013 Base Matrices.

8.5.1.1 Sligo SATURN Model 2009 Base Matrices

Demand matrices used for the 2009 base model were made available to Jacobs. The demand matrices were calibrated as part of the 2009 Base Model and were developed based on a series of Roadside Interviews carried out in September 2005. For both the AM and PM periods one-hour peak matrices were developed: 08:00 – 09:00 and 17:00 – 18:00 respectively. For the IP Period an average Interpeak hour was used. There were two category matrices in the 2009 Base: Light Vehicles and Heavy Vehicles.

8.5.1.2 NTpM 2013 Base Matrices

TII provided matrices from the 2013 Base NTpM, cordoned to align with the Sligo SATURN model extents. These matrices consider an average AM peak hour between 07:00 – 09:00 and an average inter peak hour between 12:00 – 14:00 and consider two vehicle categories: Light Vehicles and Heavy Vehicles. As the NTpM does not consider the PM peak, an inverse of the AM peak matrices was assumed.

8.5.1.3 Development of the Prior Matrices

The Sligo SATURN Model 2009 Base matrices were the starting point for the development of the prior matrices as they contain trip patterns calibrated specifically for the Sligo area. There was limited survey data to indicate that traffic volumes had increased in the Sligo area since 2009, as such no uplift factors were applied at this stage. Where the 2015 Sligo SATURN model was cordoned, the trips associated with the lost zones were removed from the matrices, with the cordoning process providing trips to the cordoned links at the N15.

Where the 2015 SATURN model was extended, the NTpM matrices were utilised to supplement the 2009 Base matrices. As the NTpM provides matrix data in the form of aggregate zones, a zone correspondence was developed that allowed the aggregate NTpM matrices to be disaggregated to the finer 2015 SATURN model zone system.

The combination of the Sligo SATURN Model 2009 Base Matrices and the cordoned NTpM 2013 Base Matrices allowed for the creation of a set of Prior Matrices.

8.5.2 **Matrix Estimation**

Matrix Estimation (ME) is a process used to estimate a finalised demand matrix based on observed traffic count information in the format of ATC and JTC as outlined in Section 8.3 and the demand matrices. The flow replicated within the model is compared to the observed levels within traffic count datasets on links and specific turning movements at key junctions. Changes to the demand matrices are then made in order to adjust the modelled flows to levels within an acceptable variance from those observed.

The finalised matrices from the Prior Matrices process were used as matrix inputs in this process. This element was an iterative process undertaken in parallel to the calibration process. Following each ME run, the estimated matrices were assigned and compared against the calibration criteria. Where necessary amendments were made to the network, in particular at junctions through changes to signal timings, to ensure the network operated as on-site, and the ME process subsequently re-run. The following section outlines the outcome of the calibration process undertaken in parallel to the iterative ME process.

8.6 SATURN Model Calibration and Validation

8.6.1 **Background**

This phase of the base model build, calibrated and validated the base model to replicate current traffic conditions by using up-to-date matrices, observed traffic flows and journey time information to an acceptable level as per the criteria set out by TII PAG. The result was a model representative of current traffic conditions that aligned with up-to-date traffic count information, thus providing a robust basis on which to assess the forecasts and scheme proposals.

8.6.1.1 Calibration and Validation Requirements

Table 8-6 outlines the guideline acceptable levels of calibration outlined in Section 5.2 of Unit 5.1 in the PAG. For the purpose of the Sligo SATURN 2015 Base model development traffic volumes are used for calibration and journey times are used for validation.

Table 8-6: TII PAG Model Calibration and Validation Criteria

Criteria and Measures		Acceptability Guideline
Assigned hourly flows compared with observed flows		
1	Individual flows within 15% for flows between 700 & 2,700 vehicles/hour (v/h)	More than 85% of cases
2	Individual flows within 100 v/h for flows less than 700 v/h	
3	Individual flows within 400 v/h for flows greater than 2,700 v/h	
4	Total Screenline flows (>5 links) to be within 5%	
5	GEH Statistic: (i) Individual flows – GEH[60] <5 (ii) Screenline totals – GEH <4	More than 85% of cases
Modelled Journey Times compared to observed times		
6	Times within 15% or 1 minutes if higher	More than 85% of cases

8.6.2 Model Calibration

8.6.2.1 Turn Count Calibration

This section outlines the calibration of the Sligo SATURN 2015 Base model to turn counts. In general for macro models, link flow traffic volumes are generally used as the basis for model calibration, however, for the Sligo SATURN model turn counts at junctions were used. The use of turn counts at junctions instead of link flows provides for greater detail in the travel patterns as greater detail is considered through the disaggregation of the link from into the individual turning movements it comprises.

Table 8-7 outlines the calibration results for the 2015 base model for each respective time period, summarising the number and percentage of turn counts that meet the PAG criteria for link flows and for the GEH statistic. It was established from this process, that for the flow criteria each peak period exceeds the specified criteria of 85%, with percentage of turn counts meeting the criteria of a minimum of 91%. For the GEH criteria this figure drops below the 85% specified criteria, with a percentage of 73% achieving the criteria. This is not unexpected as turn counts are a more refined criteria and more difficult to achieve, especially in a macro model. In some cases, due to the zone connector loading points it may not be possible to match turning counts. As such, applying the GEH statistic to turn counts has resulted in a lower percentage achieving the criteria.

Table 8-7: Sligo SATURN 2015 Base Model Calibration

Criteria	AM Peak		Interpeak		PM Peak	
	Number (/300)	%	Number (/272)	%	Number (/278)	%
Flow	283	94%	256	94%	251	90%
GEH	215	72%	199	73%	188	68%

[60] The GEH statistic is a formulae used to compare 2 sets of traffic formulae.

8.6.2.2 Turn Count Correlation

In addition to the traffic flow GEH comparison the DMRB guidelines also recommend a correlation analysis between the observed traffic surveys and the simulated model outputs. The Correlation Coefficient (R) gives some measure of goodness of model fit. Acceptable values of R are above 0.95. The Coefficient of Determination (R^2) has been utilised which is simply the square of the Correlation Coefficient (R), to determine goodness of fit, as it is a standard spreadsheet output. The DMRB states that acceptable values of R are above 0.95, which translates into acceptable values of R^2 being above 0.9025.

Figure 8-9, Figure 8-10 and Figure 8-11 details the correlation comparison of traffic flows by scatter plot. The correlation results for the Sligo SATURN 2015 Base Model are within the criteria set by the DMRB for the correlation analysis; the AM, IP and PM peaks having R^2 values of 0.9519, 0.9286 and 0.9273 respectively.

Figure 8-9: Saturn Correlation Analysis – AM Peak

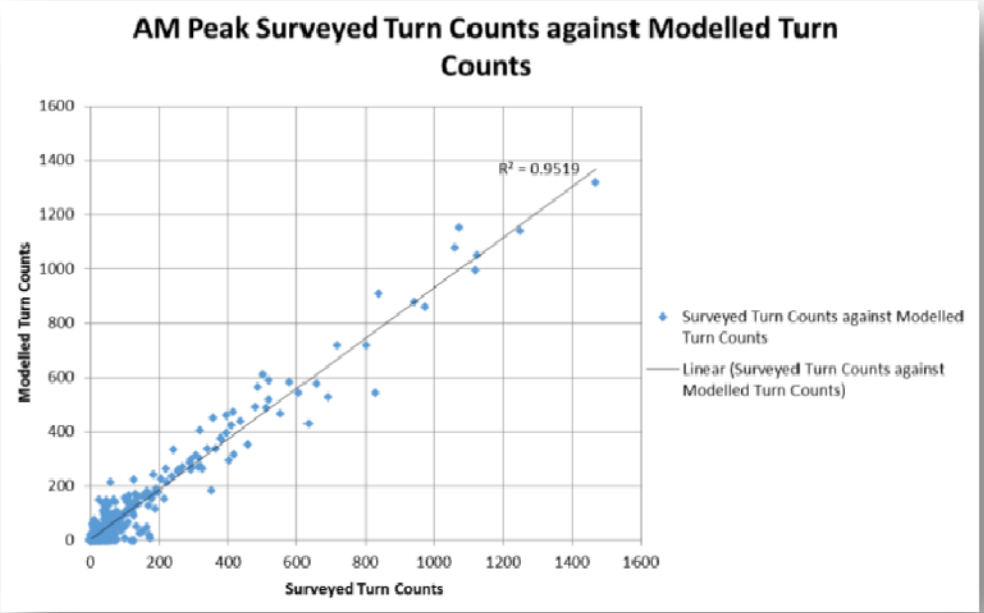


Figure 8-10: Saturn Correlation Analysis – Inter Peak

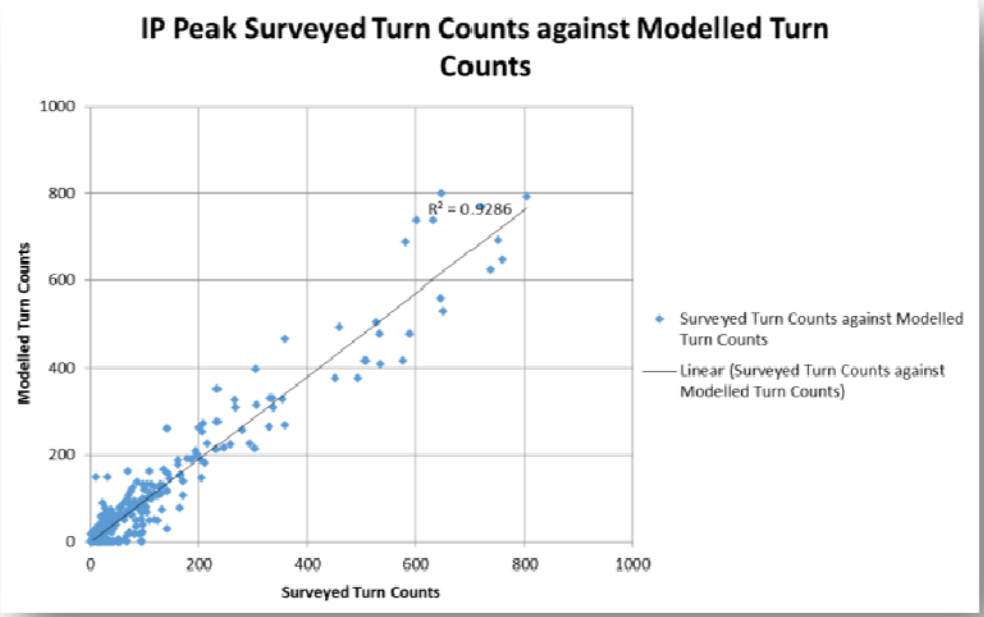
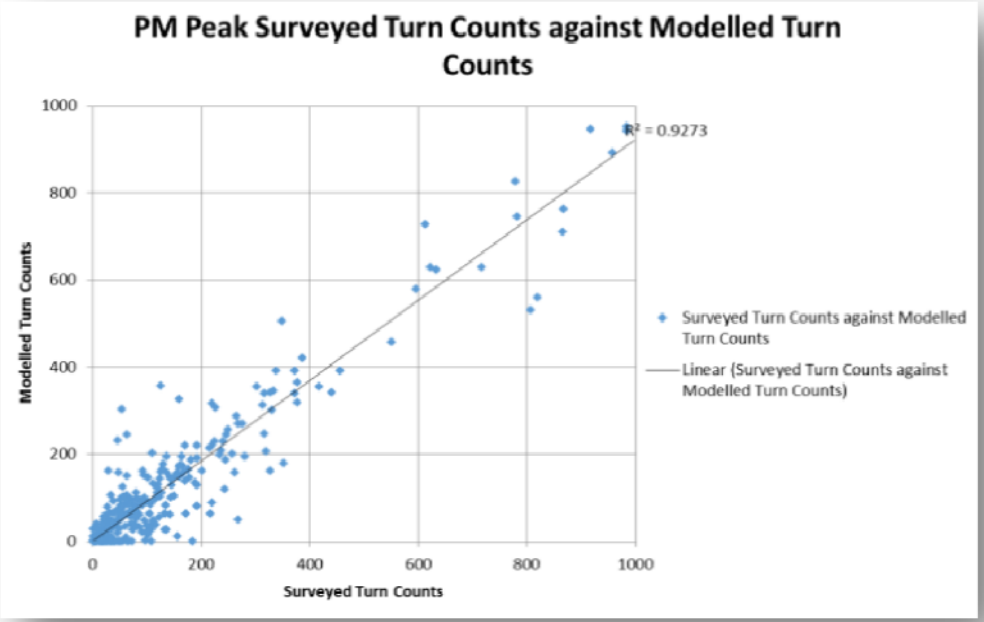


Figure 8-11: Saturn Correlation Analysis – PM Peak



8.6.2.3 Calibration Summary

The model is considered to have achieved a good level of calibration, with the link flow and correlation analysis exceeding the recommended minimum guidelines. While the GEH analysis does not achieve the PAG targets, it has been undertaken for turn counts rather than link flows, which

considers a more refined dataset in greater detail than the link flows. The GEH analysis nevertheless shows a relatively good level of comparison based on the more detailed dataset comparison.

8.6.3 Model Validation

The model validation has been undertaken based on the journey times, comparing the observed with the modelled journey times. As outlined earlier the PAG sets the validation criteria for modelled journey times, compared with observed times, to be within 15%, or one minute if higher, in more than 85% of cases. The journey time survey data collected in both directions along bi-directional four routes, outlined in section 8.3.9, in September / October 2015, has been used for this validation exercise.

Table 8-8 to Table 8-10 detail the comparison of modelled journey times relative to the observed times for the AM, Interpeak and PM periods respectively. It can be seen that for all time periods the journey time validation criteria has been met with 87.5% of journey times being within the PAG criteria.

The yellow route represents the journey time survey that corresponds with the N16 route in question. It should be noted that the journey times modelled typically have a longer duration than the observed in a southbound direction and typically have a shorter duration than the observed in a northbound direction. It can be seen that the southbound journey time in the PM peak is slightly outside the recommended range. While this could have been addressed through localised amendments to the speed flow curves, it was felt best not to as in the model the same speed flow curves have been applied in both directions. It was considered appropriate to retain this consistency of coding within the model.

Table 8-8: AM Journey Time Validation

Route	Observed Time	Modelled Time	Difference	% Difference	Within 15%
Route 1 / Yellow Northbound	00:07:13	00:06:36	00:00:37	8.60%	Yes
Route 1 / Yellow Southbound	00:07:49	00:08:41	00:00:52	11.10%	Yes
Route 2 / Green Northbound	00:07:42	00:06:50	00:00:52	11.30%	Yes
Route 2 / Green Southbound	00:05:48	00:05:24	00:00:24	7%	Yes
Route 3 / Red Northbound	00:07:17	00:06:20	00:00:57	13%	Yes
Route 3 / Red Southbound	00:08:46	00:08:30	00:00:16	3%	Yes
Route 4 / Purple Northbound	00:08:54	00:06:59	00:01:55	21.60%	No
Route 4 / Purple Southbound	00:09:08	00:08:24	00:00:44	8%	Yes
Validation Criteria Achieved					87.5% Yes

Table 8-9: Interpeak Journey Time Validation

Route	Observed Time	Modelled Time	Difference	% Difference	Within 15%
Route 1 / Yellow Northbound	00:07:14	00:06:24	00:00:50	11.50%	Yes
Route 1 / Yellow Southbound	00:07:42	00:08:21	00:00:39	8.30%	Yes
Route 2 / Green Northbound	00:06:57	00:07:00	00:00:03	0.70%	Yes
Route 2 / Green Southbound	00:05:30	00:05:47	00:00:17	5.20%	Yes

Route	Observed Time	Modelled Time	Difference	% Difference	Within 15%
Route 3 / Red Northbound	00:07:41	00:06:21	00:01:20	17.40%	No
Route 3 / Red Southbound	00:07:35	00:07:34	00:00:01	0.30%	Yes
Route 4 / Purple Northbound	00:07:27	00:06:36	00:00:51	11.50%	Yes
Route 4 / Purple Southbound	00:08:28	00:07:24	00:01:04	12.60%	Yes
Validation Criteria Achieved					87.5% Yes

Table 8-10: PM Journey Time Validation

Route	Observed Time	Modelled Time	Difference	% Difference	Within 15%
Route 1 / Yellow Northbound	00:07:17	00:06:25	00:00:52	12%	Yes
Route 1 / Yellow Southbound	00:08:30	00:09:55	00:01:25	16.70%	No
Route 2 / Green Northbound	00:08:32	00:07:47	00:00:45	8.70%	Yes
Route 2 / Green Southbound	00:06:54	00:07:15	00:00:21	5.20%	Yes
Route 3 / Red Northbound	00:07:32	00:06:30	00:01:02	13.80%	Yes
Route 3 / Red Southbound	00:07:45	00:07:38	00:00:07	1.50%	Yes
Route 4 / Purple Northbound	00:08:31	00:07:15	00:01:16	14.90%	Yes
Route 4 / Purple Southbound	00:08:42	00:08:33	00:00:09	1.70%	Yes
Validation Criteria Achieved					87.5% Yes

8.6.4 2015 Base Sligo SATURN Model Calibration and Validation Summary

For the calibration process, a detailed approach was undertaken using a more refined dataset; that the flow criteria is met, the GEH criteria still achieves a high level of correlation and that the correlation analysis meets the required criteria, indicate the trip matrices and the road network are considered to have been calibrated adequately for all time periods. In addition the journey time validation criteria have been achieved for all time periods.

Based on the results of the calibration and validation process the Sligo SATURN 2015 Base Model is considered to be calibrated and validated to a good standard.

8.7 Forecast Demand Growth

8.7.1 Forecast Scenarios

In order to ensure that the proposed scheme can operate efficiently and deliver benefits into the future, forecasts were required to determine the likely future levels of traffic on the road network. Accurate traffic forecasts are a critical input in ensuring that capacity for transport infrastructure is neither too large nor too small to meet the future demand. Furthermore, traffic forecasts inform the economic appraisal of transport schemes and therefore play a fundamental role in deciding whether a scheme is to progress.

The PAG outlines forecast years that should be considered as part of the assessment of schemes and as part of the economic appraisal. The following outlines the forecast scenarios considered as part of the proposed scheme, in line with the TII PAG:

- 2015 Base Year;
- 2017 Opening Year;
- 2032 Design Year (Opening Year + 15); and
- 2047 Forecast Year (Opening Year + 30).

The 'Opening Year', 'Design Year' and 'Forecast Year' will be uplifted to a representative year at Design Stage and following the establishment of specific scheme extents, i.e. the Opening Year will be uplifted to a more realistic time horizon and, the Design and Forecast years will be factored accordingly.

8.7.2 Derivation of Growth

The default forecasts were derived from the TII National Transport Model (NTpM). These forecasts are based on high, medium and low growth predictions of population, economic growth, car ownership, labour force and jobs drivers. Cordoned NTpM forecast matrices were received from TII for the study area, consisting of internal and external zones. Figure 8-12 illustrates the NTpM zone system as cordoned for use with the Sligo SATURN modelling assessment.

The current forecast horizons in NTpM are 2030 and 2050. To align the NTpM forecasts with the N16 Route Selection Study forecast years the NTpM growth was interpolated to derive the 2017 Opening Year, 2032 Design Year and 2047 Forecast Year.

The NTpM only provides trip matrix data for the AM peak and the Interpeak time periods. To produce a PM forecast growth the NTpM AM demand matrices were inverted to approximate the PM peak travel patterns.

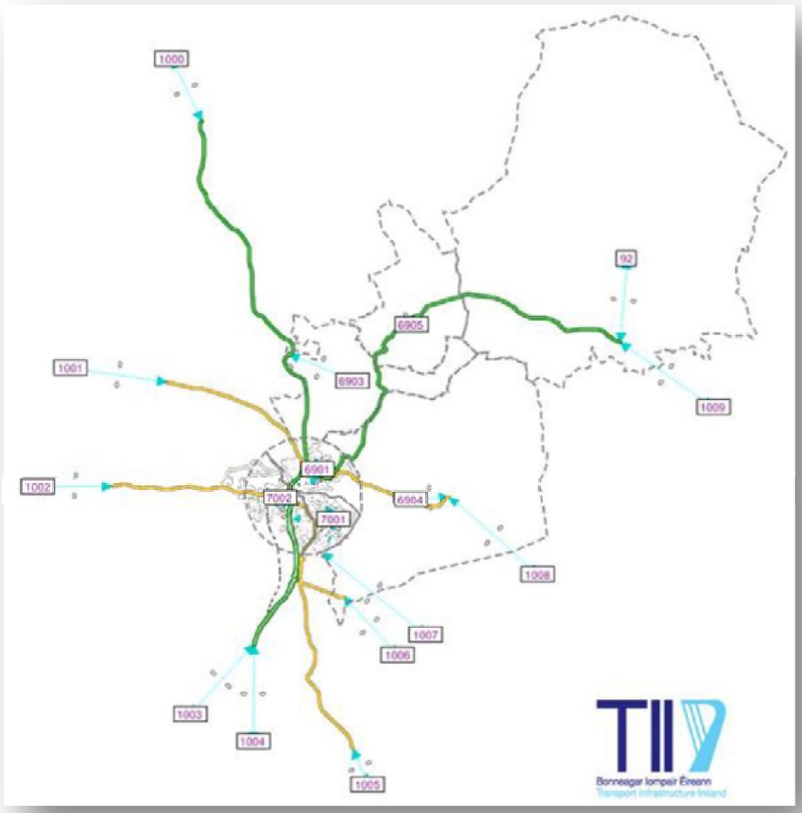
Forecast growth difference matrices were developed for the NTpM zone system, essentially subtracting the NTpM base matrices from the NTpM forecast matrices, these forecast difference matrices can be added onto the Sligo SATURN 2015 Base demand matrices to derive the forecast traffic matrices. This applies the absolute difference in traffic volumes from the NTpM to the SATURN matrices. This ensures that the detail of the calibrated SATURN matrices are retained while the spatial intelligence and forecast growth from the NTpM model is utilised.

The TII NTpM provides growth rates based on the zoning system for the area, which has approximately 9 zones in the Sligo area with 8 zones on the cordoned periphery of the model. Each zone would have its own growth rate applied to it based on the NTpM forecasts.

The NTpM uses an aggregate zone system when compared to the zone system developed for the Sligo SATURN model. The matrix data received from the NTpM covers 17 NTpM zones, whereas the same area in the Sligo SATURN model comprises 63 zones. A zone correspondence was developed to align the aggregate NTpM zones with the disaggregate Sligo SATURN zones, where multiple SATURN zones are represented by a single NTpM zone the NTpM demand was divided among the SATURN zones.

An absolute difference matrix approach (adding forecast growth numbers) was chosen above a percentage difference matrix approach (multiplying by growth percentage change) as the total demand in the calibrated Sligo SATURN base matrices and the cordoned Sligo NTpM base matrices vary significantly, with the SATURN matrices containing nearly twice as many trips as the NTpM matrices. As such, a percentage difference approach could significantly skew any absolute increase in demand when applied to the Sligo SATURN matrices, significantly uplifting the total trip numbers by nearly twice the uplifted values of the NTpM.

Figure 8-12: National Transport Model Zone System

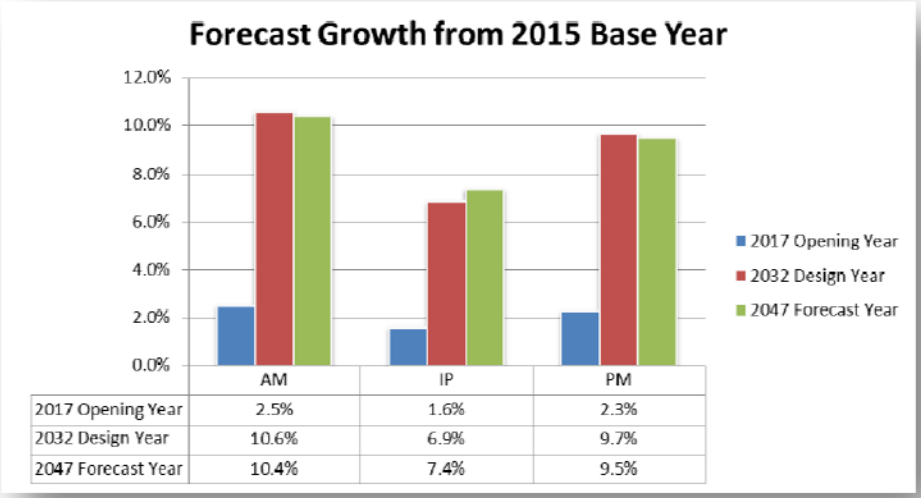


After the initial Key Performance Indicator Testing Technical Note (December 2016) was submitted, network coding refinements of the proposed schemes were programmed. At this stage, through discussions with SCC, it was deemed appropriate to undertake a slight revision to the loading of traffic growth matrices used in the emerging options taken forward, to better reflect the loading of demand from the high level TII NTpM forecasts onto the N16 network at a more disaggregate level. Following these discussions, matrix modifications were undertaken on the zones to the east of the N16, which is represented only by one large zone in the NTpM (6904). In particular, Zone 102 was identified as a low trip generator was reduced to 10%. The remaining 90% was split evenly across Zone 100 and Zone 66 where trip origins and destinations are greater. These modifications were applied only to the traffic growth and not to the underlying calibrated matrices, therefore not affecting the robustness of the modelling, but adding a more realistic loading pattern to the proposed traffic growth received from the TII NTpM.

8.7.3 Review of Forecast Demand Growth

Figure 8-13 details the forecast demand growth as a percentage increase from the 2015 Base Year for the medium growth when the absolute difference in forecast traffic volumes from the NTpM is applied to the 2015 Sligo SATURN base matrices. It can be seen that overall traffic will grow by over 10% of the 2015 level by 2032 in the AM and PM peaks. Following the 2032 forecast there is a levelling off of growth with a forecast reduction in traffic from 2032 to 2047 in the AM and PM peak periods.

Figure 8-13: Forecast Growth from 2015 Base year



	AM	IP	PM
2017 Opening Year	2.5%	1.6%	2.3%
2032 Design Year	10.6%	6.9%	9.7%
2047 Forecast Year	10.4%	7.4%	9.5%

8.7.4 Expansion to Annual Average Daily Traffic

In order to determine the Annual Average Daily Traffic (AADT), expansion factors were developed based on the AM, IP and PM peak model outputs. There is an existing TII Traffic Monitoring Unit (TMU) counter located on the N4 south of Sligo, which was used to determine the AADT expansion factors. TMU data for all of 2015 was obtained and the daily profiles for weekday traffic plotted. Assumed flat AM, IP and PM peak profiles were approximated in order to apply factors to the model peak period results. As the model considers only the weekday traffic, a reduction factor was determined to factor the Annual Average Weekday Traffic (AAWT) to obtain the AADT, which includes the weekend traffic.

Figure 8-14 and Table 8-11 outline the derivation of the expansion factors.

Figure 8-14: N4 Daily Traffic Profiles

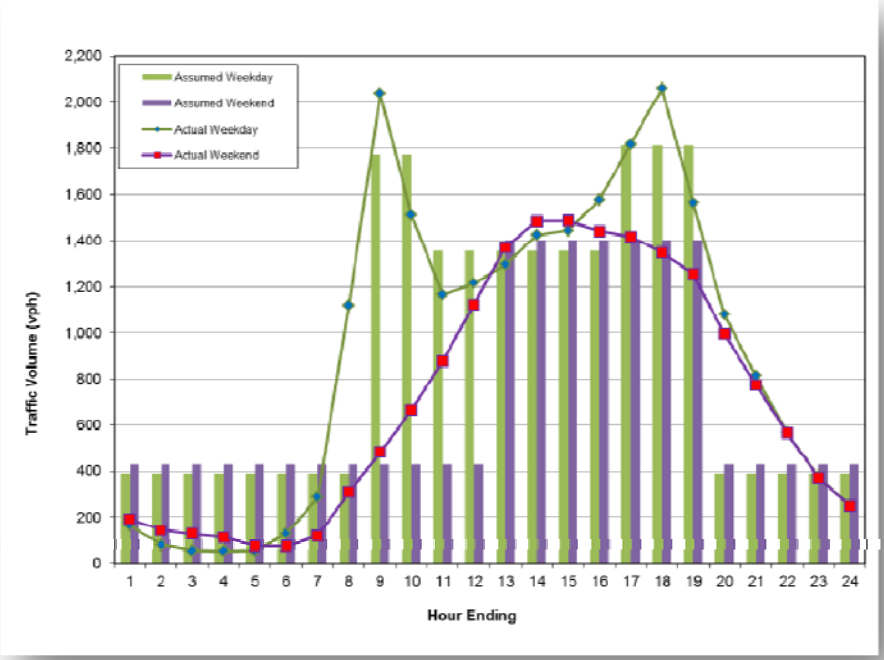


Table 8-11: AADT Expansion Factors

Factor	AM	IP	PM	OP	AADT Reduction
Expansion Factors	2	6	3	IP x 3.71	0.934

The following equations outline the expansion factors used to determine AAWT and AADT:

- AAWT = (2 x AM) + (6 x IP) + (3 x PM) + (3.71 x IP);
- AADT = 0.934 x ((2 x AM) + (6 x IP) +(3 x PM) + (3.71 x IP);

In order to expand the peak hour SATURN outputs to cover a yearly period the PAG outlines 253 weekdays to be considered. Only the 12 hour period from 07:00 to 19:00 has been considered for the annualisation factoring. These weekday annualisation factors are presented in Table 8-12 below.

Table 8-12: Annualisation Factors – AM, IP and PM

Factor	AM Peak Hour	Inter Peak Hour	PM Peak Hour
Annualisation Factor	506 (2 x 253)	1518 (6 x 253)	759 (3 x 253)

In order to include the weekend (incl. bank holidays) SATURN outputs 365 days of IP hours were considered. This was factored using 6 IP hours for 365 days (6x365 = 2190). Therefore this IP annualisation factor includes the weekday IP and the weekend periods as shown in Table 8-13.

Table 8-13: Annualisation Factors – AM, IP (with weekend) and PM

Factor	AM Peak Hour	Inter Peak Hour	PM Peak Hour
Annualisation Factor	506 (2 x 253)	2190 (6 x 365)	759 (3 x 253)

9 Stage 1 – Part 1: Preliminary Options Assessment – Feasible Route Options

9.1 Introduction

The following chapter summarises, the findings of the various specialist reports provided in Volumes 2, 3, 4 and 6 of this Route Selection Report. For a more detailed appreciation of the various assessments, the aforementioned volumes should be referred to. Volume 5 should also be referred to, for figurative details pertaining to the various assessments.

9.2 Assessment Methodology

9.2.1 Framework Matrix

A 'Framework Matrix' ranking template and an associated 'Scorecard' was developed by the project team and applied by each individual specialist to the various assessments being undertaken. Each route was relatively ranked in order of preference from 1 to 13. These ranks were then applied to the 5 separate 'Preferences' as outlined in Table 9-1.

Table 9-1: Application of Ranks to 'Preferences'

Preference	Preference Rank
Very High Preference	1
High Preference	2
Medium Preference	3
Low Preference	4
Very Low Preference	5

In consideration of the fact, that the establishment of a 'Preferred Route' is best done on an iterative basis, whereby, the establishment of an optimal route location becomes clearer as the process evolves and more detailed information becomes available, it was considered appropriate to establish 'Sectional Splits' which would allow for the breaking up of 'Feasible Route Options' and the subsequent amalgamation of preferential sections.

These 'Sectional Splints' are outlined in Figure N16-RS-002 (Volume 5) and in summary, include 3 sections described for the purposes of the Route Selection Report as the:

- Southern Section;
- Central Section; and
- Northern Section.

The only exception to the foregoing approach is the Road Safety Impact Assessment as outlined in section 9.3.3. This particular assessment was undertaken over the full length of the various route options. This was in consideration of the fact that there was little difference between the route options from a Road Safety Impact Assessment purpose in the rural area, north of the L-3406-0 (Drum Road).

9.3 Engineering Assessment

9.3.1 Traffic and Transport Assessment

The Traffic and Transport Assessment as already outlined in section 8.1 was undertaken by Jacobs Engineering. The first stage of the assessment (which evolved with the various stages of assessment) was based on 'Interim Traffic Modelling – Interim Technical Note' dated the 26th of May 2016 as included within Volume 2, Part A, of the Route Selection Report.

9.3.1.1 Assessment

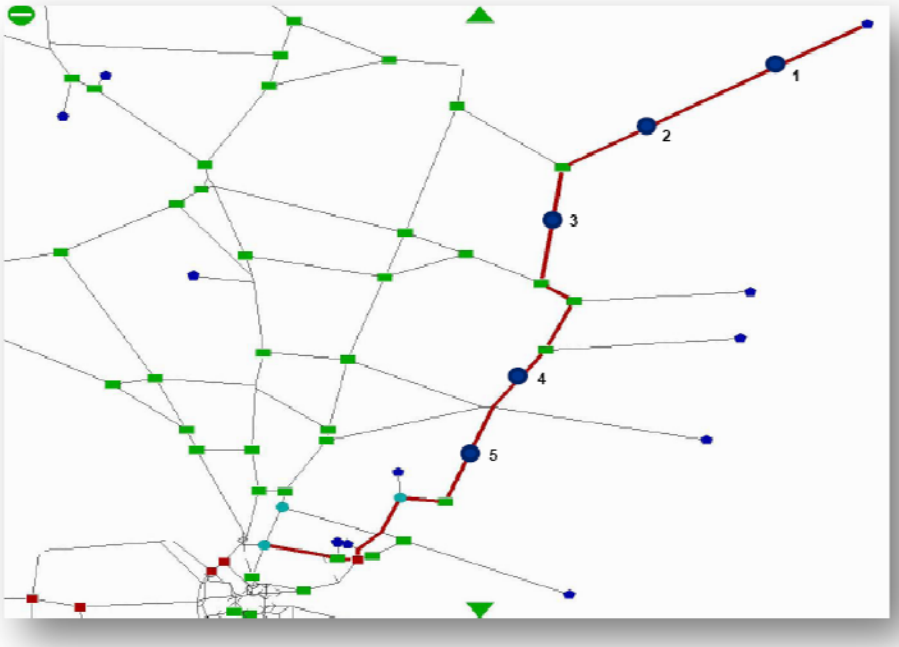
9.3.1.1.1 *Options Modelled*

The following options were modelled as part of the Stage 1, Part 1; Preliminary Options Assessment.

Do Nothing

The Do-Nothing Scenario is based on the network used in the calibrated base year model. This scenario assumes that no changes are made to the road network in the study area and network performance in 2017, 2032 and 2047 future years is modelled.

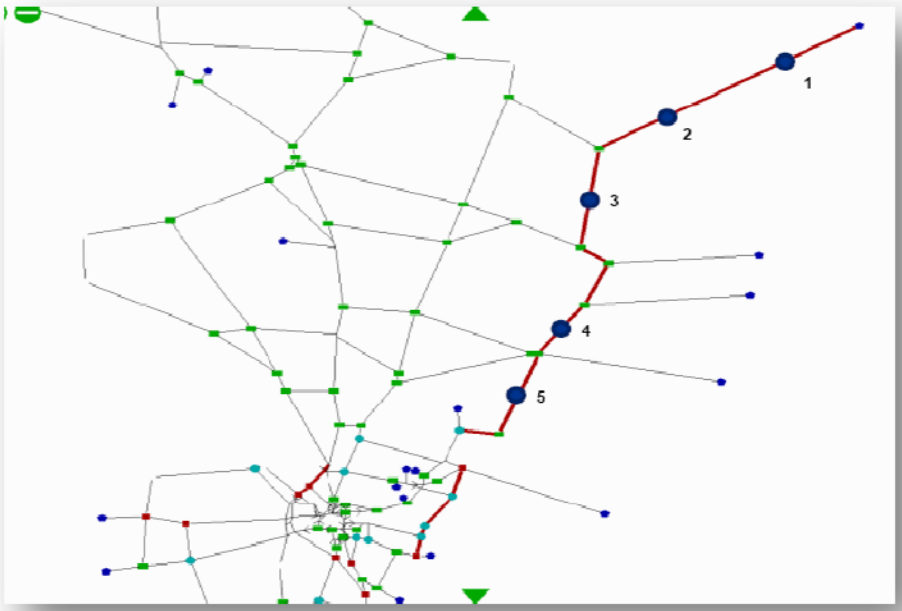
Figure 9-1: Do-Nothing Model



Do Minimum

The Do Minimum scenario includes the Eastern Garvogue Bridge (EGB) and the N4-N15 Sligo Urban Improvement Scheme (UIS). The N16 model development and assessment has considered the same Opening, Design and Forecast years as the N4-N15 UIS, namely 2017, 2032 and 2047 respectively.

Figure 9-2: Do-Minimum model with committed schemes, EGB and UIS



Strategic Options

The four strategic options comprise of different alignment arrangements for the N16, varying in lengths, junction configurations and tie-in points to the existing road network. The options modelled at this stage of the assessment have already been described in Table 8-1 contained within section 8.1 of this Main Report. Each model has the Speed Flow Curve (SFC) upgraded on the new alignment to standard single carriageway one lane rural road with free flow speed of 90 kph.

9.3.1.1.2 *Analysis of Options*

The following provides a general overview in relation to the analysis of Route Options. 'Interim Traffic Modelling – Interim Technical Note' included within Volume 2 of the Route Selection Report, should be referred to, for further information in relation to more expansive detail and numerical values.

The analysis of options included *inter-alia* an examination of:

- Average Annual Daily Traffic;
- Select Link Analysis;
- Journey Time Comparison;
- Junction Capacity;
- Network Statistics;
- Emissions;

Average Annual Daily Traffic

The initial analysis indicates that the Do Minimum traffic volumes increase on the approach to Sligo, but reduce slightly to the south of the N16 junction with the L-3407-22 due to traffic using the L-7422-0 as an alternative route to the N16.

Options 01A and 01A/01B, and Options 02A and 02A/2B, show similar patterns of traffic using the N16, with significant reductions in traffic on the N16 the closer it gets to the N15. This highlights that traffic demand on the N16 is focussed more within Sligo and results in this demand utilising the existing N16 route and the L-7421-0 as alternative routes to the proposed alignments. Option 03 retains more of the traffic demand on the proposed N16 alignment than Options 01 and 02, however, again to the south of the Option 3 connection with the L-7422-0 there is a reduction in traffic using the N16, showing that the demand is utilising the alternative route.

Options 05, 06 and 08, show similar traffic patterns, with traffic volumes on the proposed N16 alignments increasing closer to Sligo. This suggests that these routes generally cater for the demand to Sligo, with limited use of the alternative routes to the N16. Option 05 caters for the highest demand levels of all of the alignment options, followed by Option 08.

Select Link Analysis

A select Link Analysis (SLA) was carried out on each model variant to present the routing pattern for traffic using the N16 in the inbound direction for the AM peak. The routing along the N16 for each option is presented in Figure 9-3 to Figure 9-12 below.

It is apparent, that the introduction of the Eastern Garvogue Bridge in the Do Minimum scenario causes changes to the routing of traffic using the N16 inbound. The Eastern Garvogue Bridge provides an alternative crossing of the Garvogue River to the current crossings in the City Centre. This reduces traffic using the City Centre part of the network, making the routes to and from the current crossings more desirable than in the existing situation. This results in traffic routing from the N16 onto the L-7422-0 to enter Sligo via the Ballytivnan Road, in the Do Minimum scenario.

The increase in attractiveness of the Ballytivnan Road on traffic accessing Sligo, results in the under-utilisation of the proposed N16 alignment on a number of the option alignments. Options 01A, 01A/01B, 02A, 02A/02B, 03 and 06 are observed to have similar routing towards the City Centre via Avondale and Ballytivnan Road, whereas option 05 and option 08 are observed to retain the demand along the N16 option alignment.

The thickness of the green line in these figures generally outlines the trip attraction (on the study area road network) of all N16 traffic approaching Sligo on each of the various route options.

Figure 9-3: AM Do Nothing Inbound

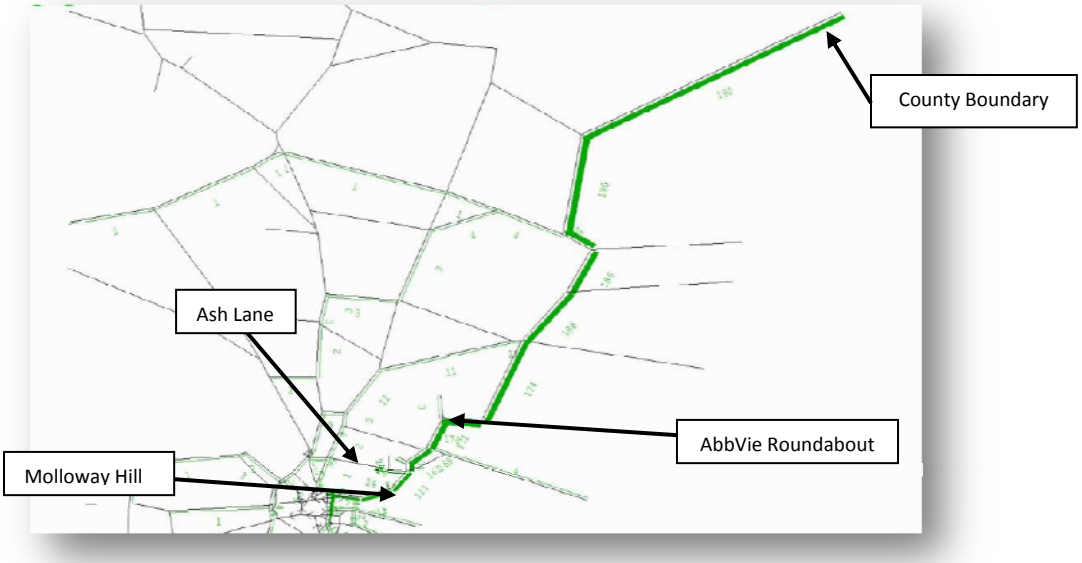


Figure 9-4: AM Do Minimum Inbound

Figure 9-5: AM Option 01A Inbound

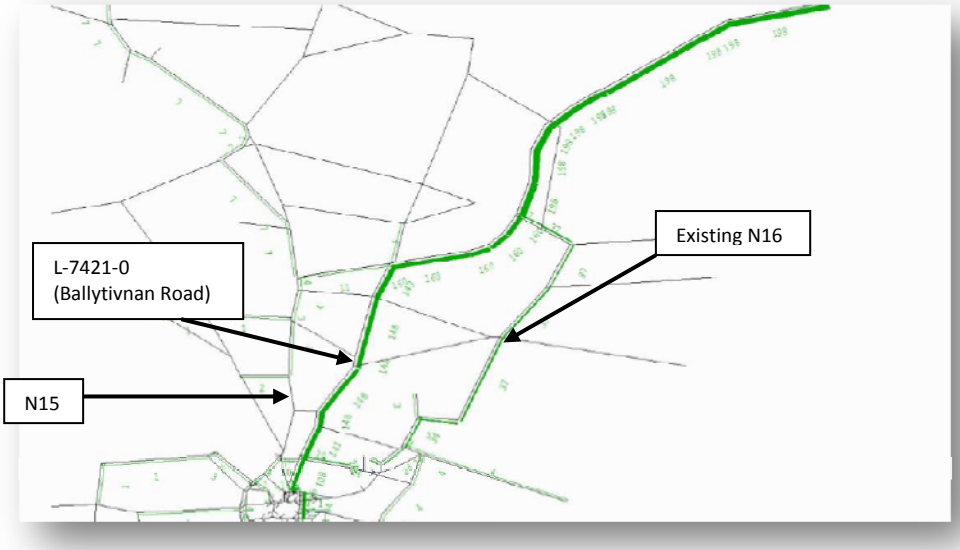


Figure 9-6: AM Option 01A/01B Inbound

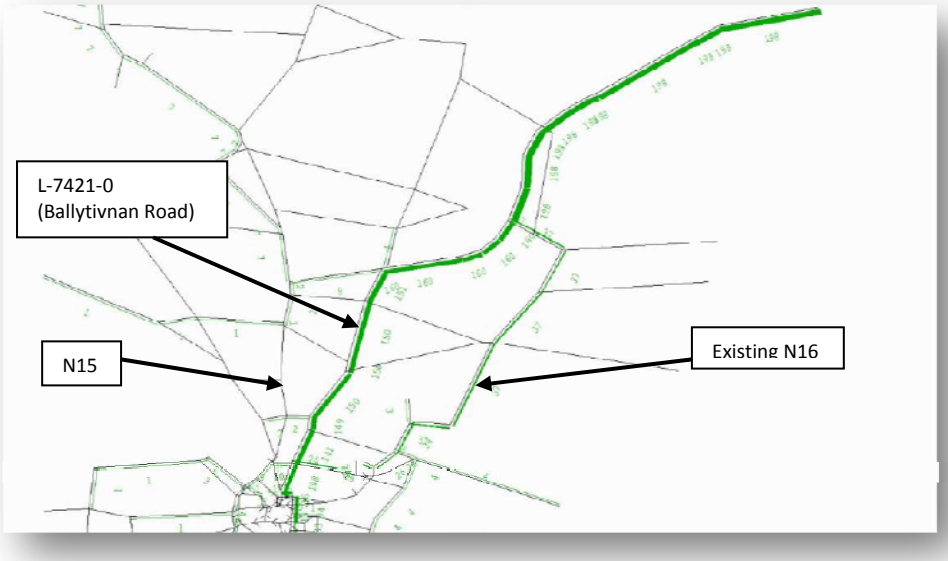


Figure 9-7: AM Option 02A Inbound

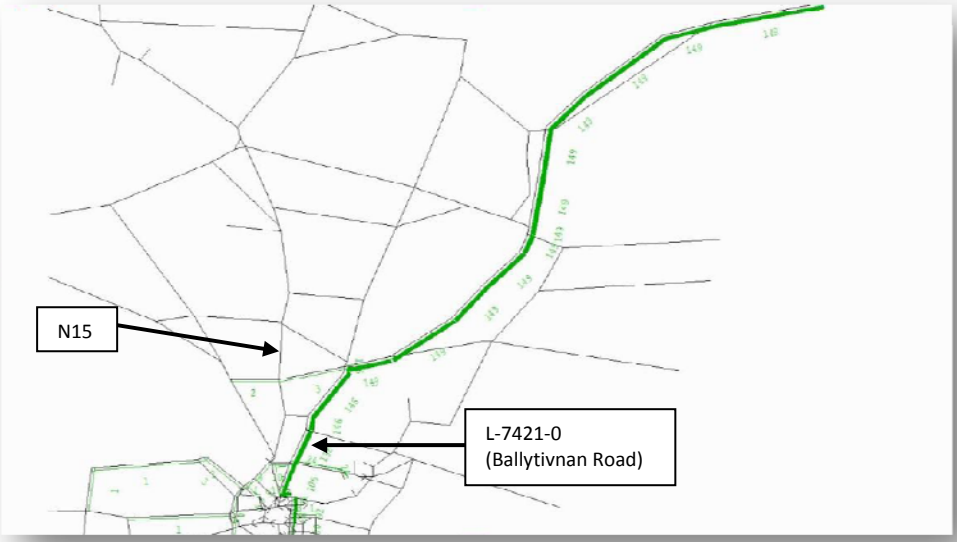


Figure 9-8: AM Option 02A/02B Inbound

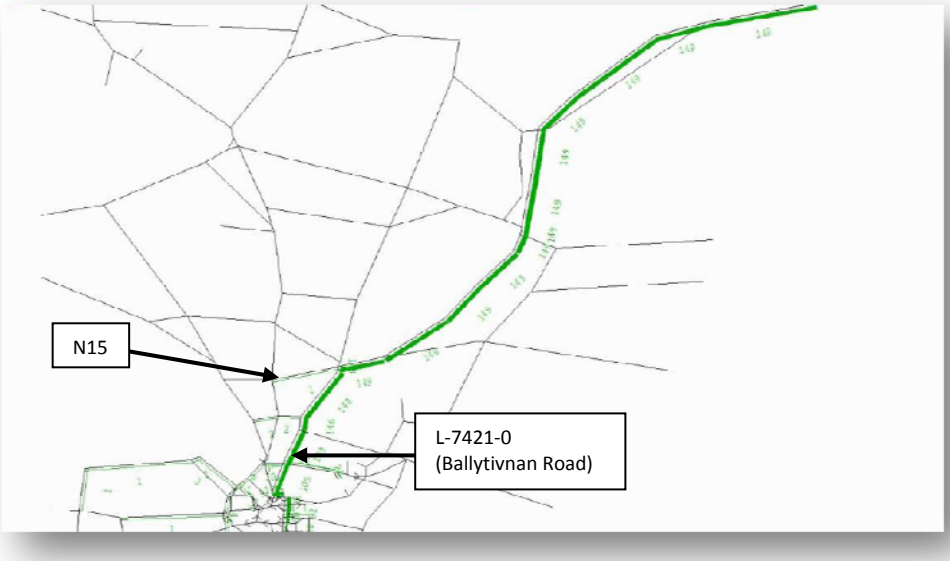


Figure 9-9: AM Option 03 (incl. options 04, 10 & 11) Inbound

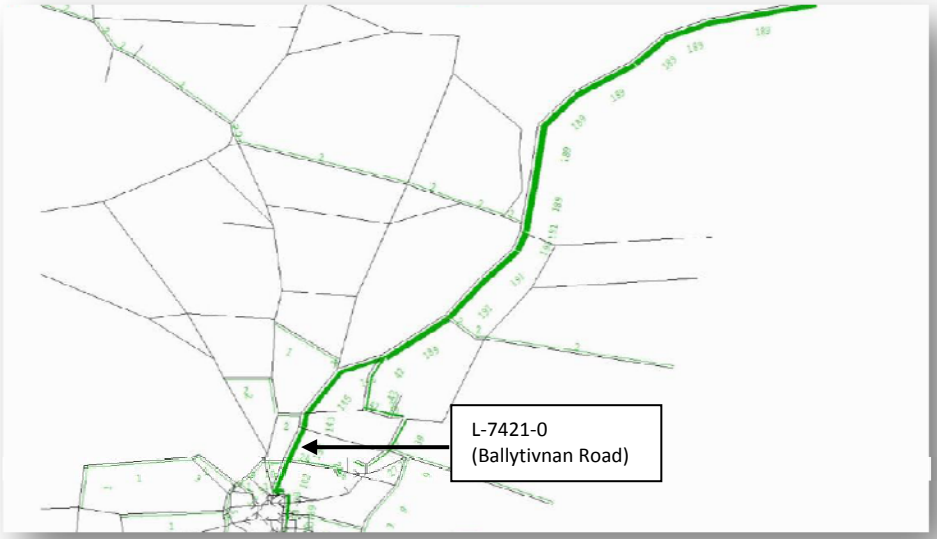


Figure 9-10: AM Option 05 Inbound

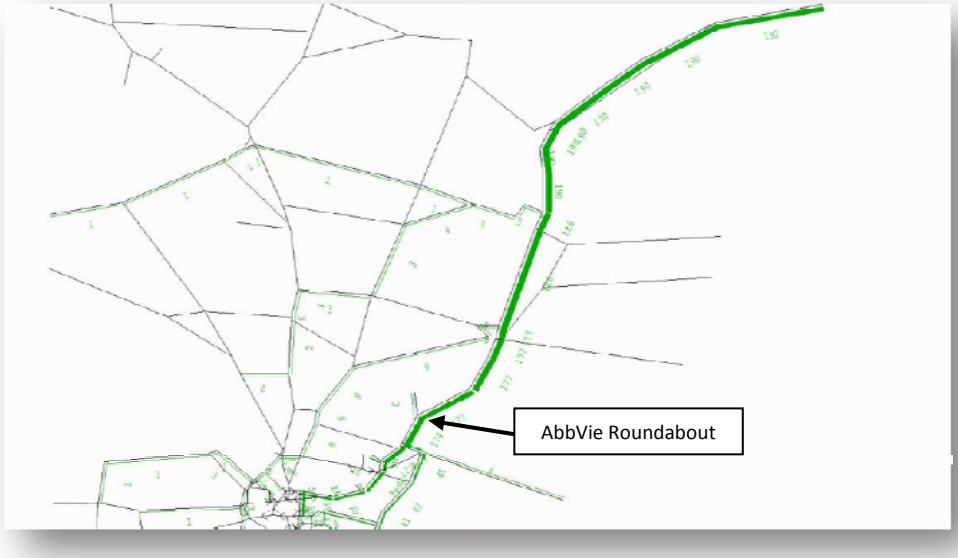


Figure 9-11: AM Option 06 Inbound

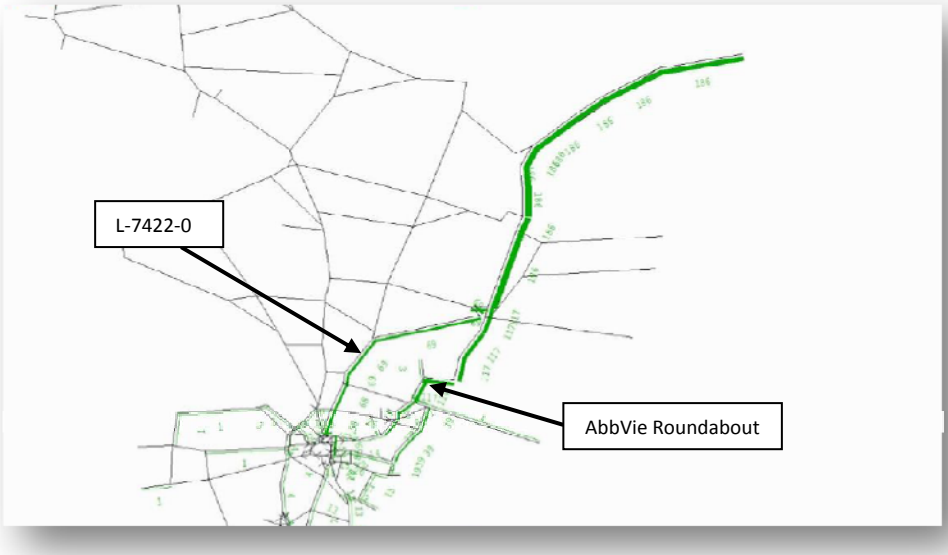
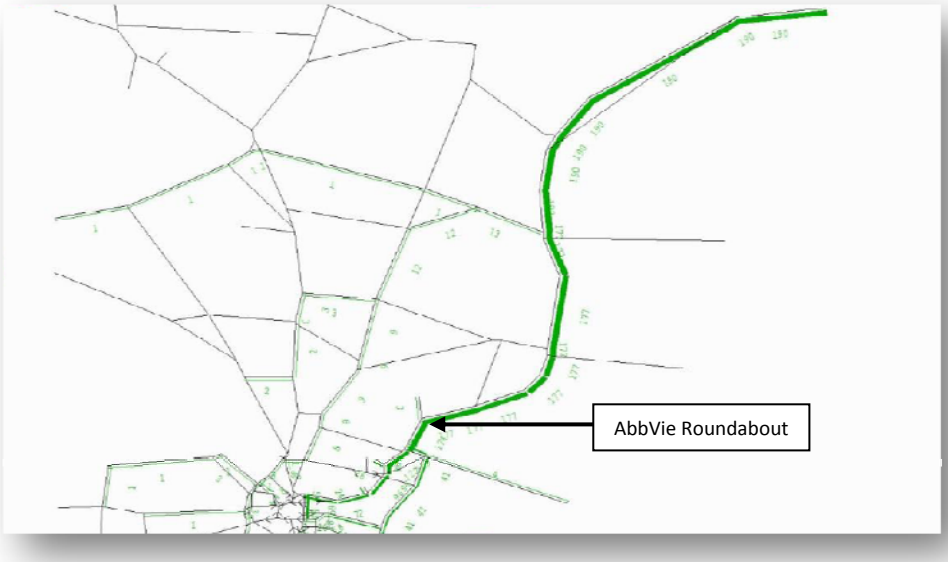


Figure 9-12: AM Option 08 (including options 07 and 09) Inbound



Journey Time Comparison

The AM, IP and PM peak journey time comparisons for the N16 route options between the junction of the N15 and N4 in Sligo as far as the Leitrim county boundary across Opening, Design and Forecast years is presented in the 'Interim Traffic Modelling – Interim Technical Note' included within Volume 2, Part A (Section 2), of the Route Selection Report.

The results show a marked reduction in journey time for the Do Something options compared to the Do Nothing and Do Minimum scenarios across all time periods. Option 02A/02B and 03 offer the minimum journey times in both directions across all options. In general, northbound journey times are relatively less than southbound traffic due to high inbound traffic volumes during the AM peak.

The Design year 2032 and Forecast year 2047 journey times are only marginally different owing to expected tapering of demand from 2032 onwards and thus minimal growth in demand for travel.

Junction Capacity

The Volume/Capacity (V/C) ratio is a measure of sufficiency of capacity relative to demand. This assessment shows that for the Do-Minimum scenario, the V/C ratios reduce in the centre of Sligo as traffic is attracted away from Hyde Bridge and Bridge Street as a result of both the Eastern Garvogue Bridge and Urban Improvement Scheme, when compared to the Do Nothing scenario.

In the Do-Something scenario the V/C ratios along the proposed scheme reduce while the V/C ratios in the centre of the City remain relatively close to those in the Do-Minimum scenario due to the improved capacity associated with the proposed scheme.

Network Statistics

This assessment examined the transient queuing, over-capacity queuing, total travel time, travel distance and average speed in the AM, IP and PM periods respectively for the strategic option scenarios in 2047.

Transient queuing relates to the overall level of queuing throughout the network that occurs associated with typical under-capacity junction operation, but ultimately can be accommodated by the network. Over-capacity queuing relates to the level of queuing associated with junctions that have reached capacity. Total travel time is the total amount of travel time summed for all trips made on the network. The travel distance is the total distance travelled summed for all trips made on the network. The average speed relates to the average vehicle speed of traffic over the entire network.

The introduction of the Do Something options is shown to generally improve network operations further when compared to the Do Minimum, with queuing levels and travel times reducing. The travel distance is generally seen to increase above the Do Minimum as the proposed scheme improvements make it a more attractive route than the potentially shorter routes through the city for certain trips. Average vehicle speeds are also seen to increase due to the improvements to the N4 network operation. It should be noted however that the values given are averages based on the entire network. The cruise speeds remain the same but demand increases reducing the network speeds.

Emissions

This element of the assessment details the vehicle pollutant emissions from the 2047 forecasts experienced for Carbon Monoxide, Carbon Dioxide, Nitrous Oxides and Hydro Carbons. These are network wide vehicle emissions resulting from the proposed scheme as modelled in the SATURN model. As the tabulated data shows (See Volume 2, Part A, Section 2), the Do Minimum scenario reduces emissions when compared with the Do Nothing scenario. The introduction of the Do Something options is seen to reduce emission levels further below the Do Minimum level.

9.3.1.1.3 *Assessment Conclusion*

Based on the initial 'Interim Technical Note', Table 9-2 (Feasible Route Options) averages the results of the various Traffic & Transport Assessment sub-criteria and provides a preference ranking for each route option.

Table 9-2: Traffic and Transport Summary – Feasible Route Options

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Total	4	4	4	4	1	1	1	3	2	2	2	1	1

9.3.2 **Road Engineering**

The Road Engineering Assessment was undertaken by the TII National Road Design Office in Sligo County Council. The full assessment is included in (Volume 2, Part B, Section 2) of the Route Selection Report.

9.3.2.1 Assessment[61]

9.3.2.1.1 *Outline*

In general, the assessment compares the geometric properties of the various route options against the required standards and in particular those set out in DN-GEO-03031[62] (formerly, NRA TD 9/12, Road Link Design). The following are the criteria which were subjected to the assessment:

- Horizontal Alignment;
- Vertical Alignment;
- Stopping Sight Distance;
- Full Overtaking Sight Distance;

A separate criterion was also examined relating to Constructability. The length of the Route Options did not influence the Engineering Assessment, they are however assessed in the Road Safety Impact Assessment (Volume 2, Part B, Section 4, of the Route Selection Report) and in the Traffic & Transport section of the Route Selection report, which for example measures the wider journey time benefits. However; for information purposes, Table 9-3 outlines the lengths of the Feasible Route Options.

Table 9-3: Feasible Route Options – Length

	Travel Distance			
FRO	Physical Works Length (m)	Additional journey TO N15 Junction with N16 (m)	Additional journey TO N16 Junction with R286/Molloway Hill (m)	Total Journey Distance (m)
Option 01A	7,125	2,500	-	9,625
Option 01A/1B	9,625	-	-	9,625
Option 02A	8,180	1,180	-	9,360
Option 02A/02B	9,360	-	-	9,360
Option 03	8,220	680	-	8,900

[61] These assessments were undertaken in advance of certain changes to aspects of the DMRB which occurred in April 2017.

[62] TII, Design Manual for Roads and Bridges

FRO	Travel Distance			
	Physical Works Length (m)	Additional journey TO N15 Junction with N16 (m)	Additional journey TO N16 Junction with R286/Molloway Hill (m)	Total Journey Distance (m)
Option 04	8,310	680	-	8,990
Option 05	7,680	-	840	8,520
Option 06	7,880	-	840	8,720
Option 07	8,110	-	840	8,950
Option 08	8,130	-	840	8,970
Option 09	8,020	-	840	8,860
Option 10	8,220	680	-	8,900
Option 11	8,220	680	-	8,900

9.3.2.1.2 *Criteria*

Horizontal Alignment

The Horizontal Alignment assessment examined the route options in terms of the 'Design Speed Related Parameters' and also, in terms of Figure 7/6 (Horizontal Curve Design) of DN-GEO-03031 and the banding requirements described therein. In general the assessment was based on the occurrence of the following various horizontal geometries:

- Curves occurring in Band B, or, Band D, of the aforementioned Figure 7/6 and which are also of a Desirable Minimum standard;
- Curves requiring a Relaxation from standard;
- Curves requiring a departure from standard.

The results of the horizontal alignment assessment, which is expanded upon in Volume 2, Part B, is outlined in Table 9-4.

Table 9-4: Feasible Route Options - Horizontal Alignment Ranking

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	1	1	1	1	1	1	1	3	1	3	1	1
Central	1	1	1	1	1	1	1	1	1	1	1	1	1
North	1	1	1	1	1	1	1	1	1	1	1	1	1
Overall	1	1	1	1	1	1	1	1	2	1	2	1	1

Options 07 and 09 generally received lower preferences, relative to other options, due to the requirement for a design standard 'One Step' relaxation in the Southern section.

Vertical Alignment

The Vertical Alignment assessment examined the Feasible Route Option's (FRO's) in terms of the aforementioned 'Design Speed Related Parameters' and also, in terms of desirable maximum and

minimum[63] gradients as required by Section 4 of DN-GEO-03031. In general, the assessment was based on the occurrence(s) of the following various vertical geometries:

- Curves to Des-Min, or curves which provide full FOSD, where they occur in Band B horizontal curves;
- Curves requiring a Relaxation from Standard;
- Curves requiring a Departure from Standard;
- Vertical Gradient less than 1% (for drainage);
- Vertical Gradient greater than 5%;
- Vertical Gradient greater than 6% (Relaxation);

The result of the vertical alignment assessment, which is expanded upon in volume 2, is outlined in Table 9-5.

Table 9-5: Feasible Route Options - Vertical Alignment ranking

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	2	2	3	3	1	1	3	3	2	2	2	1	1
Central	1	1	1	1	1	2	1	1	1	1	1	1	1
North	1	1	2	2	1	1	1	1	1	2	2	2	2
Overall	1	1	2	2	1	1	2	2	1	2	2	1	1

Options which required relaxations to design standards generally received the lower preference ranking, with the frequency of relaxations determining whether they received a 'High', or 'Medium' preference. In all these instances, it is not expected that 'Departures' from standard will be required.

Stopping Sight Distance

The 'Stopping Sight Distance' assessment examined the FRO's in terms of the aforementioned 'Design Speed Related Parameters' and also in terms of the permitted application of 'Relaxations' to standards as described in Section 2 of DN-GEO-03031. In this regard, each Feasible Route Option was examined for the occurrence of 'Stopping Sight Distances' within the following thresholds:

- SSD > 215m;
- SSD > 200m;
- SSD > 180m;
- SSD > 120m;
- SSD < 215m in the vicinity of a junction.

The results of the Stopping Sight Distance assessment, which is expanded upon in Volume 2, Part B, is outlined in Table 9-6.

Table 9-6: Feasible Route Options – Stopping Sight Distance Ranking

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	1	4	4	4	3	4	3	3	4	4	3	3
Central	2	2	2	2	2	2	3	3	1	2	1	2	2
North	1	1	2	2	3	3	1	1	1	3	1	1	1
Overall	1	1	3	3	3	3	3	3	2	3	2	2	2

[63] The minimum gradient as required by DN-GEO-03031 was increased from 0.5% to 1% to reflect the requirements of TII IAN 09 which requires a minimum 1% gradient on areas of super elevation.

In the South section, Options 04, 06, 07, 10 and 11 are all ranked 'Medium' preference resulting from the fact, that they each require a 'One Step Relaxation' in design standards combined with each of them requiring sight line improvements in the vicinity of junction locations (in order to ensure compliance with the 'Desirable Minimum' standard). 'Low' preference rankings are attributed to Options 02A, 02A/02B, 03, 05, 08 and 09, primarily as a result of 2 and 3 step relaxations in combination with the requirement for sightlines improvements in the vicinity of junction locations.

In the 'Central' section; options 05 and 06 were ranked 'Medium Preference' resulting from the fact, that they each require a 'One Step' relaxation in design standards combined with each of them requiring sight line improvements in the vicinity of junction locations (in order to ensure compliance with the 'Desirable Minimum' standard).

In the 'Northern' section; Options 03 and 04 were ranked 'Medium' preference, resulting from the fact that they each require a 'One Step' relaxation in design standards combined with each of them requiring sight line improvements in the vicinity of junction locations (in order to ensure compliance with the 'Desirable Minimum' standard).

Full Overtaking Sight Distance

DN-GEO-03031 recommends the levels of overtaking value to be provided on differing Road Types. The values are outlined in Table 9-7.

Table 9-7: Rural Road Types – Overtaking Value

Rural Road Type	Overtaking Value
Type 2 and Type 3 Single	15%
Type 1 Single	30%

An MX Roads analysis carried out on each Feasible Route Option, established the various overtaking values attributable per option. Notwithstanding the thresholds in the aforementioned Table 9-7 and considering the fact that, greater FOSD generally provide greater journey time benefits, the assessment established 3 separate criteria for assessment, these include as follows:

(1) FOSD (580m) Greater than 30%;

(2) FOSD (580m) Between 15% and 30%;

(3) FOSD (580m) below 15%.

The results of the Full Overtaking Sight Distance assessment, which is expanded upon in volume 2, Part B, is outlined in Table 9-8.

Table 9-8: Feasible Route Options – Full Overtaking Sight Distance Ranking

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	1	2	2	2	2	2	2	2	2	2	2	2
Central	1	1	1	1	2	2	2	2	2	2	2	2	2
North	1	1	1	1	1	1	1	1	1	1	1	1	2
Overall	1	1	1	1	2	2	2	2	2	2	2	2	2

Generally, it was observed from this aspect of the assessment that all routes provided good FOSD characteristics.

Constructability

Constructability of all the route options will be complex in certain areas, due to the extent of existing residential housing, commercial businesses, farms, local roads and accesses dotted along the length of the route options. Disruption to residences and local traffic will need to be minimised throughout the construction period. Detailed assessment of these impacts will be carried at the next stage of the development process, i.e. Phase 3, Design and Phase 4, Statutory procedures.

It follows that the route option with the greatest length of on-line construction will be most difficult to construct. In addition, it is likely that in extreme cases diversions will be required at a wider geographical scale in order to construct these sections; this will have temporary impacts in terms of journey times and in terms of the amenity of the regional routes where diversions are directed – this impact is assessed separately, in monetary terms, as part of the 'Options Comparison Estimate' under the heading of Residual Network (See Volume 2, Part B, Section 5 of the Route Selection Report).

The route options have been ranked based on the length of online construction expected, with the 'Very High' preference ranks being attributed to the options which will be the most straight forward to construct and the 'Very Low' preference ranks being attributed to those which are most difficult to construct. In order to quantify and compare the various different options in terms of 'Constructability', the following percentages of sections of route which were online were used to undertake the assessment:

- 0% to 5% of route online;
- 5% to 25% of route online;
- 25% to 50% of route online;
- 50% to 75% of route online;
- 75% to 100% of route online;
- Difficult local interactions with the existing N16

The results of the Constructability assessment, which is expanded upon in Volume 2, Part B, is outlined in Table 9-9.

Table 9-9: Feasible Route Options – Constructability Ranking

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	3	1	2	1	1	2	3	1	1	1	1	1
Central	2	2	2	2	2	1	2	2	1	1	1	2	2
North	3	3	3	3	4	4	3	3	2	2	2	2	2
Overall	2	3	2	2	3	2	2	3	1	1	1	2	2

Generally, in the southern section, options 01A/01B and 06 were considered more difficult to construct and were each attributed 'Medium' preference ranks.

In the northern section, due to online realignment, constructability is more difficult, with options 03 and 04 considered to be 'Low' preference, followed by options 01A, 01A/01B, 02A, 02A/02B, 05 and 06, which are each considered to be 'Medium' preference.

Junction Strategy

At this stage in the design process, the junction strategy has not been fully developed. For the purposes of comparison it has been assumed that there will be equal treatment for each option, this is in consideration of the fact that design year traffic figures dictate that no junction grade separation is required, in this regard all junctions will be at grade, with roundabout('s) generally provided at strategic connection points.

Earthworks

Earthworks extents and volumes are assessed under the Soils and Geology section of the Route Selection Report, therefore they are not considered under the Road Engineering heading.

Drainage

Each of the route options will require the provision of road surface water facilities. Based on initial assessments, the requirements for each of the corridors will be similar in scale and will discharge to the same receiving waters.

9.3.2.1.3 *Assessment Conclusion*

Based on the engineering assessment, Table 9-10 (Feasible Route Options) averages the results of the various geometry sub-criteria and provides a preference ranking for each route option. In general, all routes are considered to be 'Very High' preference, or 'High' preference overall.

Table 9-10: Engineering Summary – Feasible Route Options

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	2	2	2	2	2	2	2	2	2	2	2	2
Central	1	1	1	1	2	2	2	2	1	1	1	2	2
North	1	1	2	2	2	2	1	1	1	2	1	1	2
Overall	1	1	2	2	2	2	2	2	1	2	1	2	2

9.3.3 Road Safety Impact Assessment

9.3.3.1 Outline

The Road Safety Impact Assessment Report (RSIA) which is an 'Assessment of Project Need' as required by EU Directive 2008/96/EC, Road Safety Infrastructure Management, was undertaken by the Sligo, TII National Roads Project Office. The embedded report in full is provided in Volume 2, Part B, Section 4 of the Route Selection Report.

The RSIA was prepared with reference to the NRA 2010 Project Management Guidelines (PMG) which states an RSIA to be:

> *... a strategic comparative analysis of the impact of a Scheme on the safety performance of the road network. An RSIA must be carried out on all Schemes at the initial Planning stage, i.e. during Phases 1 and 2. EU Directive 2008/96/EC defines RSIA and requires it to be carried out for all infrastructure projects on the Trans-European Road Network...*
> *...This assessment may also be carried out in the early part of Phase 2 – refer to the NRA Inspector for advice on this issue.*[64]

Additionally, the structure and contents are based upon the requirements set out in PE-PMG-02001 (formerly NRA HD 18/12) Road Safety Impact Assessment standard. The scope of the impact assessment as defined in the aforementioned standard is as follows:

> *2.2 The primary purpose of a Road Safety Impact Assessment is to demonstrate, on a strategic level, the implications on road safety of different planning alternatives of an infrastructure project.*

[64] NRA (TII) Project Management Guidelines, 2010

2.3 The Road Safety Impact Assessment shall indicate the road safety considerations which contribute to the choice of the proposed solution. It shall further provide all relevant information necessary for the selection of the solution, including a comparative analysis of the road safety implications of each alternative considered and an evaluation of the road safety benefits and disbenefits arising from each alternative.

The RSIA sets out the Proposal Definition, Need for the Scheme & Problem Definition, Scheme Safety Objectives, The Consideration of Alternatives, and the Analysis of Road Safety Impacts.

9.3.3.2 Assessment

Prior to undertaking the assessment, the RSIA team, examined the overall context of the 'Feasible Route Options' and how they may interact with the receiving environment in relation to road safety impacts. A general consensus having regard to the nature of the proposal, concluded with the establishment of criteria, which could be used to undertake the assessment; these criteria and the reasoning for their selection are outlined below:

Length

The 'Length' of each particular 'Feasible Route Option' was considered important, insofar as the length of a route generally dictates the journey times (considering an average 'Level of Service' applied to each Route Option) – this has implications in terms of the likelihood of accidents on a given route, considering similar designs for each route option;

Junctions & Side Roads

It is generally recognised in road design, that there is a relationship between accident statistics and the frequency of junctions. In this regard, assuming uniform junction design(s) across each 'Feasible Route Option', the density of the number of junctions attached to a particular route was assessed. Additionally, connections between the realigned local roads and the existing local network were also assessed, recognising that in some cases the connection between the new and existing local network may provide for differing cross sections, or symmetries of layout;

Online Sections - Direct House Accesses

The general objective, in relation to the design of 'Feasible Route Options' and where they interact with direct accesses, is that these direct accesses will, where feasible, be grouped together and reconnected back into the national network through adjoining local road connections. There are instances however, where this will be difficult (and in some cases not possible) such as at online sections where house and agricultural entrances directly abut the national road. This will increase the density of junctions and in this regard is assessed accordingly in the RSIA.

Tie In to National Network (North & South)

Tie-In's from a road safety perspective, were considered important by the assessment team for two particular reasons:

- They can result in instances where a newly upgraded road is connected to a substandard section. This can result in an inconsistency of road layout and increased speeds coming into deficient sections;
- They generally result in online works, which increases the requirements for Traffic Management during construction;

In this regard, the Tie-In's at the terminus points have been assessed in terms of how they interact with the existing Network.

Impact on the existing National & County Network – Including Vulnerable Road Users

New roads by their nature have the potential to impact on, or change the characteristics of the residual road network. This may include for example, an increase in traffic on some local roads. With the aid of the Traffic Model outputs, these interactions were assessed in the RSIA.

In addition, this element of the assessment, focused on vulnerable road users which generally includes those people who do not have the perceived safety of being inside a car behind them. In the main these users include pedestrians and cyclists. The assessment examined areas along 'Feasible Route Options' where there was likely to be significant interaction in the urban area/and or locations where there would be expected to be sensitivities in relation to vulnerable road users.

9.3.3.3 Assessment Conclusion

The results of the assessment are outlined in Table 9-11. In conclusion, it is apparent that Option 01A/01B has the highest number of 'Very Low' preference' ranks owning to aspects related to its 'Length', 'Junctions & Side Roads', 'Online Sections' and impacts on the existing 'National & County Network'; this is followed closely by Option 01A, which also scores poorly under 'Length', 'Online Sections' and impacts on the existing 'National & County Network'.

Options 02A/B and Option 4 are in the overall 'Low' preference rank while Options 02A, 03, 06, 10 and 11 are in the overall 'Medium' preference rank. Each of these options (with the exception of Option 06) have an attributed 'Very Low' preference or 'Low' preference scored against them under two, or more, of the various assessment criteria which the RSIA was undertaken with.

The best overall ranking options are Option 05, 07 and 09 ('Very High' preference) followed by Option 08 which has an overall 'High' preference rank. It is also notable however, that there are no 'Very Low Preference' or 'Low' preference ranks attributed to options 05, 06, 07, 08 or 09. It can therefore be deduced from an RSIA perspective, that the latter options are the most favourable from an RSIA perspective.

Table 9-11: Master RSIA Matrix Framework – Feasible Route Options

Elemental Criteria		RSIA 'FEASIBLE ROUTE OPTIONS' RANKING													
		Do-Nothing/Do Minimum	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Length	Opt. Rank	N/A	13	13	10	10	4	7	1	2	7	7	3	4	4
	Matrix Rank	N/A	5	5	4	4	2	3	1	1	3	3	2	2	2
Junctions & Side Roads - Local Network Connections	Opt. Rank	N/A	3	13	1	10	10	8	6	7	1	5	3	12	9
	Matrix Rank	N/A	2	5	1	4	4	3	3	3	1	3	2	5	3
Online Sections - Direct House Accesses	Opt. Rank	N/A	11	12	6	6	6	6	6	6	6	6	6	1	1
	Matrix Rank	N/A	4	5	3	3	3	3	3	3	3	3	3	1	1
Tie In (North)	Opt. Rank	N/A	7	7	7	7	7	7	7	7	7	7	7	1	1
	Matrix Rank	N/A	3	3	3	3	3	3	3	3	3	3	3	1	1
Tie In (South)	Opt. Rank	N/A	6	1	8	6	10	10	5	9	2	3	3	10	10
	Matrix Rank	N/A	3	1	3	3	4	4	3	3	1	2	2	4	4
Impact on the existing National & County Network - including vulnerable road users	Opt. Rank	N/A	13	13	11	11	11	11	1	5	3	3	3	11	11
	Matrix Rank	N/A	5	5	4	4	4	4	1	3	2	2	2	4	4
Overall Score	Opt. Rank	N/A	53	59	43	50	48	49	26	36	26	31	25	39	36
Score (incl. L)	Matrix Rank		5	5	3	4	3	4	1	3	1	2	1	3	3

9.4 Economy Assessment (Options Comparison Estimate)

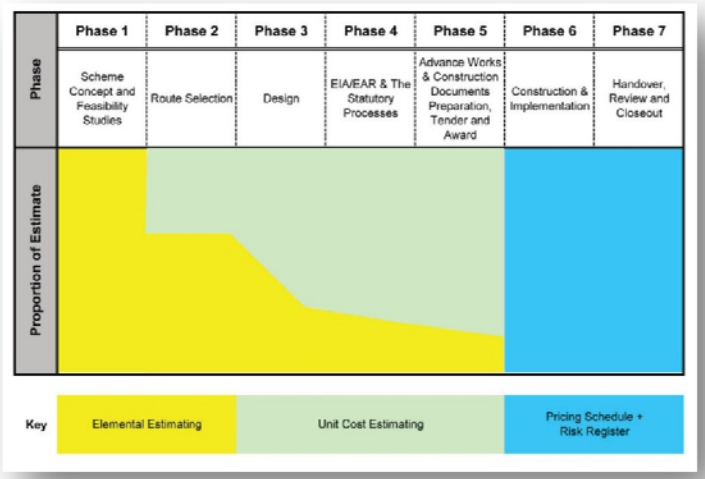
9.4.1.1 Outline

The Options Comparison Estimate was undertaken by the Sligo TII National Roads Project Office. The full assessment is included in Volume 02, Part B, Section 5 of the Route Selection Report.

9.4.1.2 Assessment

The estimating strategy recommended by the TII Cost Management Manual and adopted for this Route Selection Report, is a combination of Elemental and Unit Cost Estimate (Figure 9-13).

Figure 9-13 Route Selection Estimating Methodology[65]



Elemental costs are arrived at, by '*multiplying quantities of elements by monetary rates with lump sum provisions for some elements*'[65]. Unit cost estimating is *'based on breaking down project elements into various works activities and then multiplying the resultant quantities for each activity by unit costs'*[65]. As the scheme information at the Route Selection Stage is rudimentary in nature, the base cost estimate mainly consists of elemental estimating, with some exceptions for key features.

The estimate (which includes risk contingencies) was derived for each route option, using the 7 cost headings as per the Cost Management Manual, namely:

(1) Planning and Design;

(2) Land and Property;

(3) Archaeology;

(4) Advance Works and Other Contracts;

(5) Main Construction Contract;

(6) Main Contract Supervision; and

(7) Residual Network.

[65] TII Cost Management Manual, March 2010

This estimate type is also required to undertake and complete the Cost Benefit Analysis (TuBA) for those options which proceed to Stage 2 (Project Appraisal).

9.4.1.3 Comparative Analysis

Table 9-12 outlines the comparative analysis[66] carried out for the Feasible Route Options. In conclusion, the following is apparent in relation to the various sectional splits.

9.4.1.4 Southern Section

The most expensive options to construct are generally options 03, 04 10, 11. In this regard these options are given 'Low' preference ranks.

'Medium' preference options are considered to be Options 01A/01B, 02A, 02A/02B, 06 and 07. The best ranked options in the Southern Section are Options 01 and 08 ('Very High' preference) followed by Options 05 and 09 ('High' preference).

9.4.1.5 Central Section

The most expensive options to construct are generally options 01A and 01A/01B ('Very Low' preferences) followed by option 02A and 02A/02B ('Low' preference).

'Medium' preference options are considered to be Options 03, 04, 06, 10 and 11. The best ranked options in the Central Section are Options 08 and 09 ('Very High' preference) followed by Options 05 and 07 ('High' preference).

9.4.1.6 Northern Section

The most expensive options to construct are generally options 05 and 06 ('Very Low' preferences) followed by option 10 ('Low' preference).

'Medium' preference options are considered to be Options 01A, 01A/01B, 02A, 03 and 04. The best ranked options in the Northern Section are Options 02A/02B, 07, 08, 09 and 11 ('Very High' preference).

[66] The ranking procedure adopted, does not consider the N15 Dual Carriageway improvements which are part of Options 01A/B and 02A/B.

Table 9-12: Feasible Route Options – Comparative Estimates

FRO	South			Central		North	
	Approx Cost (€ Million)	N15 Dual Carriageway Cost	Preference Rank	Approx Cost (€ Million)	Preference Rank	Approx Cost (€ Million)	Preference Rank
Option 01A	€ 9.01		1	€ 7.89	5	€ 7.28	3
Option 01A/1B	€ 12.89	€ 21.37	3	€ 7.89	5	€ 7.28	3
Option 02A	€ 12.38		3	€ 6.85	4	€ 6.96	1
Option 02A/02B	€ 12.38	€ 21.37	3	€ 6.85	4	€ 6.96	1
Option 03	€ 14.96		4	€ 6.57	3	€ 7.07	3
Option 04	€ 14.61		4	€ 6.59	3	€ 7.09	3
Option 05	€ 11.75		2	€ 5.92	2	€ 8.25	5
Option 06	€ 12.97		3	€ 5.93	2	€ 8.25	5
Option 07	€ 11.87		3	€ 5.68	2	€ 6.96	1
Option 08	€ 11.74		1	€ 5.40	1	€ 6.96	1
Option 09	€ 11.79		2	€ 5.40	1	€ 6.96	1
Option 10	€ 14.96		4	€ 6.56	3	€ 7.70	4
Option 11	€ 14.96		4	€ 6.56	3	€ 6.93	1

9.5 Environment Assessment

9.5.1 **Socio Economic**

9.5.1.1 Outline

The Socio Economic Assessment was undertaken by Optimize Environmental Consultants. The full assessment is included in Volume 3, Part A, of the Route Selection Report.

The assessment addresses the potential social and economic (community) effects on Human Beings presented by the alternative route options being considered.

9.5.1.2 Impact Categories and their Assessment

Construction impacts

Impacts during the construction period are difficult to assess at the stage of this options assessment due to the limited information currently available. However, some assessment can be made on the basis of the location of communities, or community facilities and:

- The effect of construction traffic on journey or general amenity;
- Effects on environmental and residential amenity.

Operational impacts

Impacts during the operational phase fall into four key categories, namely:

1. Journey characteristics: An assessment of potential impacts on local journey time, journey time reliability (i.e. the assurance of completing a journey within a predictable time range) and travel patterns including connectivity;
2. Community severance: An assessment of potential impacts with regard to any severance from community facilities, particularly those used by older people, children or other sensitive or vulnerable groups. The category includes both new severance and relief from existing severance;

3. Amenity: This category includes journey amenity arising from the exposure of pedestrians and cyclists to traffic (due to proximity, safety, noise, dirt, poor air quality) as well as impacts for all road users arising from factors such as visual intrusion and congestion. In addition, impacts on general amenity are addressed where amenities and residential quality of life are affected;
4. Economic impacts: an evaluation of each route in the context of economic development and employment.

The assessment generally addresses impacts at a community level, rather than for individuals or identifiable properties, although impacts for individual businesses are discussed where these are located beside the road or are very dependent on road traffic or accessibility. Impacts on individual properties are addressed separately in section 9.5.2 of this Route Selection Report. There are also interactions arising from possible impacts identified in the chapters on Landscape and Visual Assessment, Noise and Vibration and Air Quality in particular.

9.5.1.3 Assessment

All of the route options provide benefits particularly in terms of improved journey amenity for all users (walkers, cyclists and drivers) using the N16/existing N16 due to the transfer of traffic, separation of regional/commuting and local traffic and improved sightlines. There are benefits to journey characteristics in terms of improved journey time reliability and improved connectivity and also general amenity benefits to most properties along the existing N16 due to the transfer of traffic. The prospective impacts of each of the options vary, depending in the volume of traffic remaining on the N16, the remaining functionality of the existing N16 for local and cycle journeys, impacts on local businesses (direct impacts and passing trade) and impacts in terms of access to properties, social severance and tourism.

Table 9-13 illustrates the relative preference scores of each option in terms of the socio-economic impact.

Table 9-13: Feasible Route Options, Impact scores - Socio-economics

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	5	4	4	3	4	4	2	2	3	1	3	4	4
Central	5	5	3	3	3	4	2	2	2	2	2	3	3
North	2	2	2	2	2	2	2	2	2	2	2	2	2
Overall	5	5	4	3	4	4	2	2	2	1	2	4	4

Much of the above assessment summary hinges on the treatment of severance in Ballytivnan by Options 03 and 04. The potential impact here is significant rather than profound and could be mitigated to a certain degree, by good pedestrian and cyclist crossing facilities. The options receive a higher ranking than 01A and 01A/01B in that they remove more traffic form the existing N16 and provide for journey connections to the N15 and an eastern river crossing without adding to existing severance in Cartron. However, while the options do provide connectivity to the two AbbVie plants, they also bisect the area in between. While a connection would be possible, this would involve land-take that could restrict development options.

The Socio Economic assessment, also recommended that a distributor road connection be considered for Options 05 to 09 from the N16 to the N15. This could provide connectivity to Ballytivnan and the AbbVie plant, but also to Cartron via other proposed road enhancements at the N15. The level of severance could be moderated by the lesser capacity of the road.

9.5.2 Property (other than Agricultural)

9.5.2.1 Outline

The Property (other than Agricultural) Assessment was undertaken by John Bligh & Associates. The full assessment is included in Volume 3, Part A, of the Route Selection Report.

9.5.2.2 Assessment

The route options appraisal comprises of a quantitative assessment of non-agricultural property for each route option. This assessment is based on direct impacts from the Feasible Route Option alignments including a 10m offset from the extents of the alignment to allow for detailed drainage and earthworks design.

A further assessment was conducted within 10-30m of the extents of the alignment to identify potential significant direct impacts. For online sections of Route Options, 01A/01B and 02A/02B, a detailed design is available and the assessment was solely based on the extents of the alignment.

For non-agricultural property, Feasible Route Options are evaluated in terms of:

- A survey count of:
  - Residential property;
  - Commercial / industrial property;
  - Community property, amenity and open space; and
  - Development property.
- Property impact.

The ranking of the impact of route options on non-agricultural property is based on assessment criteria as presented in Table 9-14.

Table 9-14: Non-agricultural impact criteria on property

Impact	Criteria
High	An impact on the property where the use of the property cannot continue. Acquisition of a residential house Acquisition of a commercial property Acquisition of a community property Acquisition of development property.
Medium	An impact on the property where the use of the property can continue. An impact of permanent duration resulting in a significant change to the character of the property. Residential – Significant effects on house curtilage and garden. Commercial – Significant effects on entrance, parking and commercial lands. Community – Significant effects on entrance, parking and community lands. Development – Significant effects on part of development property.
Low	An impact on the property where the use of the property can continue. An impact of permanent or temporary duration with a minimal or temporary effect on the character of the property. Residential – Slight effects at property boundary and / or garden. Commercial – Slight effects at property boundary and / or entrance.

Impact	Criteria
	Community – Slight effects at property boundary and / or entrance. Development – Slight effects at property boundary.

The impact assessment ranking and selection of preferences for Feasible Route Options are based on the criteria as presented in Table 9-15.

Table 9-15: Impact assessment criteria for Feasible Route Options

Impact	Preference	Criteria
Major Negative	Very Low Preference	Significant impacts on property of national or regional importance. Residential properties include significant number of High impacts. Commercial properties include significant number of High impacts.
	Low Preference	Residential property impact includes a slight number of High impacts. Commercial property impact includes a slight number of High impacts. Community property impact may include a significant number of High impacts. Development property may include a significant number of High impacts.
Moderate Negative	Medium Preference	There are no High impacts on Residential property. There are no High impacts on Commercial property. Community property impact may include a slight number of High impacts. Development property impact may include a slight number of High impacts.
Minor Negative	High Preference	There are no High or Medium impacts on Residential property. There are no High or Medium impacts on Commercial property. There are no High impacts on Community property. There are no High impacts on Development property.
Neutral	Very High Preference	No effect on non-agricultural property.
Positive	Very High Preference	Not applicable to non-agricultural property.

An overall summary of the assessment of the Feasible Route Options (FRO) is presented in Table 9-16. This involved a quantitative assessment of direct impacts on residential, commercial, community and development property for each section of FRO in the study area. Each of the FRO sections were assessed using the impact criteria as presented in Table 9-15.

For the Southern section of the study area, the impact on non-agricultural property was deemed to be Moderate Negative on Feasible Route Options 02A, 02A/02B, 05 and 06 resulting in a Medium preference. The impact was deemed to be Major on the remaining options with a Low preference on FRO 01A (incl. high impact on 1 property), 01A/01B (incl. high impact on 2 houses, and 2 plots of development land), 07 (incl. high impact on 2 houses), 08 (incl. high impact on 1 house) and 09 (incl. high impact on 2 houses) and a Very Low preference on FRO 03, 04, 10 and 11 (due to impacts on development lands which are of regional significance).

For the Central section, the impact on non-agricultural property was deemed to be Minor Negative on FRO 02A, 02A/02B, 03, 04, 05, 06, 10 and 11 resulting in a High preference. The impact is

Moderate Negative on 07, 08 and 09 resulting in a Medium preference. There is a Major Negative impact on FRO 01A (inc. high impact on 3[67] houses) and 01A/01B (as per 01A) resulting in a Very Low preference.

On the Northern section, the impact on non-agricultural property was deemed to be Neutral on FRO 11 indicating a Very High Preference. There is a Minor Negative impact on FRO 03 and 04 resulting in a High preference. The impact is Moderate Negative on FRO 02A/02B, 07, 08 and 09 resulting in a Medium preference. There is a Major Negative impact on the remaining options with a Low preference on FRO 01A (incl. high impact on 2 houses), 01A/01B (as per 01A) and 10 (incl. high impact on 2[68] houses) and a Very Low preference on FRO 05 (incl. high impact on 2[69] houses) and 06 (as per 05).

Table 9-16: Overall summary of non-agricultural property assessment

Feasible Route Option	Southern Section	Central Section	Northern Section
	Impact	Impact	Impact
01A	Major Negative	Major Negative	Major Negative
01A / 01B	Major Negative	Major Negative	Major Negative
02A	Moderate Negative	Minor Negative	Moderate Negative
02A / 02B	Moderate Negative	Minor Negative	Moderate Negative
03	Major Negative	Minor Negative	Minor Negative
04	Major Negative	Minor Negative	Minor Negative
05	Moderate Negative	Minor Negative	Major Negative
06	Moderate Negative	Minor Negative	Major Negative
07	Major Negative	Moderate Negative	Moderate Negative
08	Major Negative	Moderate Negative	Moderate Negative
09	Major Negative	Moderate Negative	Moderate Negative
10	Major Negative	Minor Negative	Major Negative
11	Major Negative	Minor Negative	Neutral

[67] There are also High impacts involving direct impacts on four houses considered as farm houses, however these impacts are considered as part of the assessment in the Agricultural Chapter.

[68] There is a High impact involving a direct impact on one house considered as a farm house, however this impact is considered as part of the assessment in the Agricultural Chapter.

[69] There are also High impacts involving direct impacts on three houses considered as farm houses, however these impacts are considered as part of the assessment in the Agricultural Chapter.

Table 9-17: Non Agricultural Property - Preferences

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	4	4	3	3	5	5	3	3	4	4	4	5	5
Central	5	5	2	2	2	2	2	2	3	3	3	2	2
North	4	4	3	3	2	2	4	4	3	3	3	4	1
Overall	4	4	3	3	3	3	3	3	3	3	3	4	3

9.5.3 **Noise & Vibration**

9.5.3.1 Outline

The Noise & Vibration Assessment was undertaken by Envest Environmental. The full assessment is included in Volume 3, Part A, of the Route Selection Report.

The assessment was carried out in accordance with the *TII Guidelines for the Treatment of Noise & Vibration in National Road Schemes* (2004) and the *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* (2014). In accordance with these Guidelines, the study established three elements to the Route Corridor Selection, which included the following:

- An assessment of potential impact based upon property counts;
- A consideration of likely changes in traffic flow; and
- A review of the need for, and difficulties associated with, noise mitigation measures.

9.5.3.2 Assessment

9.5.3.2.1 *Potential Impact Rating*

The Potential Impact Rating involved an identification of all sensitive receivers within 300m of each route option and assigning into one of four 'bands'. These bands are defined by their distance to either side of the centre line of each route option. Band 1 is from 0 to 50m of the centre line, Band 2 is from 50 to 100m, Band 3 is from 100 to 200m and Band 4 is from 200 to 300m. The NRA *Guidelines for the Treatment of Noise & Vibration in National Road Schemes*, states that a receiver is defined as being any dwelling house, hotel, hostel, health building, educational establishment, place of worship, entertainment venue or any other facility or area of high amenity which benefits from, or requires the absence of, high noise levels. Noise sensitive receivers have been counted, based on OSi mapping information for each route option. The total number of receivers in each band has been multiplied by an arbitrary rating factor. The rating factor is 4 for Band 1, 3 for Band 2, 2 for Band 3 and 1 for Band 4. The resultant values have been summed to give a single number for each route option, termed the Potential Impact Rating (PIR). The PIR values were used to assess the potential impact of each route option, the larger the PIR the greater the potential impact.

PIR South

Based on PIR values, Options 01A/01B & 02A/02B could be rated as the 1st and 2nd best ranked route options in terms of potential noise impact in the 'Southern' Section of the Feasible Route Options. Option 05 could be rated as the 3rd preferred route option in terms of potential noise impact.

PIR Central

Based on PIR values, Options 01B & 02B could be rated as the 1st and 2nd best ranked route options in terms of potential noise impact in the Central Section of the Feasible Route Options. Options 05 and 06 could be rated as the 3rd and 4th preferred route options in terms of potential noise impact.

PIR North

Based on PIR values, Option 10 could be rated as the best ranked route option in terms of potential noise impact in the Northern Section of the Feasible Route Options. Options 05, 06 & 11 could be rated as the 2nd preferred route options in terms of potential noise impact.

9.5.3.2.2 *Assessment of Changes in Traffic Flow*

The traffic flow data for all options indicate that there will be a very significant reduction in traffic routes. Future traffic volumes of less than 10% of the existing traffic volumes will be experienced on the existing N16 for all options except Options 01A, 01A/01B, 02A and 02A/02B. In terms of changes in traffic flow data, the potential noise impact will be beneficial to noise sensitive receivers located in close proximity to the existing N16 alignment, where the proposed N16 realignment will be further removed from their property. However, in many areas of the 'Central' section and 'Northern' section of the proposed N16 realignment, the options do not significantly deviate away from the existing N16 alignment.

Significant differences in the changes in traffic flow on various road links are predicted to occur for the various options in the 'Southern' section of the proposed N16 realignment.

Options 01A, 01A/01B, 02A & 02A/02B will result in a decrease in traffic flow on the existing N16 from the N16-R286 junction at Sligo IT to the roundabout at AbbVie and on the existing N16 north of the roundabout at AbbVie. Options 01A, 01A/01B, 02A & 02A/02B will result in a significant increase in traffic flow on the existing Ballytivnan Road, Avondale and Old Bundoran Road. For example, Option 02A/2B would result in a 72% increase in traffic flow on Avondale and a 65% increase in traffic flow on the Ballytivnan Road. Properties close to Avondale and the Ballytivnan Road would experience a discernible noise level increase with such a change in traffic flows.

Options 03, 04, 10 & 11 will result in an approximate 20% decrease in traffic flow on the existing N16 from the N16-R286 junction at Sligo IT to the roundabout at AbbVie with future traffic volumes of less than 10% of the existing traffic volumes experienced on the existing N16 north of the roundabout at AbbVie. However, options 03, 04, 10 & 11 will introduce significant additional traffic flows on existing roads adjacent to the properties near to Elm Gardens, Church View, Glendallon and The Woodlands as well as a new road link to the rear of The Grove Student Complex. Options 03, 04, 10 & 11 would result in over a doubling of traffic flows (a 115% increase) and a discernible noise level increase on Elm Gardens, Church View, Glendallon and The Woodlands and surrounding receivers.

Options 05, 06, 07, 08 and 09 will result in an increase in traffic flow on the existing N16 from the N16-R286 junction at Sligo IT to the roundabout at AbbVie, with less than 10% of the existing traffic volumes experienced on the existing N16 north of the roundabout at AbbVie. In effect, all traffic on the existing N16 will move to the proposed N16. In terms of changes in traffic flow data, the potential noise impact will be beneficial to noise sensitive receivers located in close proximity to the existing N16 alignment, where the proposed N16 realignment will be further removed from their property.

The traffic flow data on the proposed N16 realignment of in the order of 3,500 AADT indicates that existing properties adjacent to the proposed route options may experience an increase in nearby

traffic volume and therefore, a potentially significant increase in noise level compared to the currently experienced background noise levels. Existing properties in rural areas adjacent to low traffic volume roads are likely to experience a greater subjective negative response to the proposed route than those existing properties which are located in relatively closer proximity to the existing N16.

9.5.3.2.3 *Assessment of Likely Need for Mitigation Measures*

A prediction of the likely noise levels at receivers in proximity to the proposed N16 has been undertaken using the *Calculation for Road Traffic Noise* (CRTN) calculation methodology and CadnaA noise modelling software. The noise level prediction parameter is the L_{den} noise indicator as specified in the NRA document *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*. This is a composite of L_{Aeq} values for L_{Day}, $L_{Evening}$ and L_{Night}. The design goal set out in the NRA document is to achieve 60dB L_{den} (free field residential façade criterion) or less at each receptor. The NRA document states that mitigation measures are only deemed necessary when the following three conditions are satisfied at designated sensitive receptors:

- the combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal - 60dB L_{den};
- the relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place;
- the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB;

The predicted noise levels at receivers in proximity to the proposed N16 options have been used to give an initial indication of where noise mitigation measures are likely to be necessary in order to achieve the design goal of 60dB L_{den} or less at each receiver. These are outlined in Table 9-18

Table 9-18: Receivers potentially requiring Noise Mitigation.

Option No.	Number of Locations
Option 1A	6
Option 1B	6
Option 2A	14
Option 2B	14
Option 3	43
Option 4	59
Option 5	6
Option 6	2
Option 7	13
Option 8	8

Option No.	Number of Locations
Option 9	12
Option 10	41
Option 11	42

During the course of the detailed assessment of the preferred route option, the noise impact assessment methodology and detailed mitigation design will include for the use of noise prediction modelling software which will accurately determine the specific requirements for Noise Mitigation.

9.5.3.2.4 *Summary of assessment & conclusions*

The prevailing noise climate in the study area of the route options varies from rural areas with very low background noise levels to larger urban areas, which are likely to experience an elevated background noise level due to traffic flows and residential, commercial and industrial activities typical of such urban areas.

Table 9-19 outlines the preference ranking from a Noise & Vibration perspective. This assessment is based on the three elements of Route Corridor Selection outlined in *The NRA Guidelines for the Treatment of Noise & Vibration in National Road Schemes*, including an assessment of potential impact rating (PIR) based upon property counts, a consideration of likely changes in traffic flow, and a review of the need for and difficulties associated with noise mitigation measures.

Table 9-19: Summary of Feasible Route Options (Noise)

Section	Feasible Route Option												
	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11
South	4	4	4	4	4	4	2	2	2	2	2	4	4
Central	2	2	3	3	3	4	3	3	4	4	4	3	3
North	3	3	3	3	3	3	3	3	3	3	3	2	2
Overall	3	3	3	3	3	4	2	2	3	3	3	3	3

9.5.4 Air Quality & Climate Change

9.5.4.1 Outline

The Air Quality & Climate Change assessment was undertaken by Envest Environmental Consultants. The full assessment is included in Volume 3, Part A, of the Route Selection Report.

9.5.4.2 Assessment

This assessment focuses on the potential air quality and climate impacts along the various route corridors and tries to quantify and qualify these constraints as appropriate, to reach a conclusion on the most acceptable route in air quality and climate terms.

This assessment was completed in accordance with the following relevant guidance notes:

- *NRA (now TII) Guidelines for the Treatment of Air Quality in National Road Schemes during the Planning and Construction of National Road Schemes (Revised May 2011).*

In accordance with the guidelines, the following outlines the main aspects of the assessment:

9.5.4.2.1 *Calculation of the index of overall change in exposure for the existing route and each route option in the opening year*

The assessment of the calculation of the index for overall change in exposure was completed using the UK DMRB assessment for regional assessment. The index of overall change in exposure was calculated for NO_2 and PM_{10} for the different route options. The results of this assessment are outlined in tabular form in Volume 3, Part A, of the Route Selection Report.

9.5.4.2.2 *Calculation of local-scale pollutant concentrations*

The sensitive residential receptors considered as part of the air quality assessment are the existing properties in Elm Gardens, Church View, Glendallon and The Woodlands immediately adjacent to Options 03, 04, 10 & 11. Options 03, 04, 10 & 11 will result in an increase in traffic flow on the existing N16 from the N16-R286 junction at Sligo IT to the roundabout at Abbvie with future traffic volumes of less than 10% of the existing traffic volumes experienced on the existing N16 north of the roundabout at Abbvie. However, Options 03, 04, 10 & 11 will introduce significant additional traffic flows on existing roads in close proximity to the properties at Elm Gardens, Church View, Glendallon and The Woodlands. Options 03, 04, 10 & 11 would result in a 115% increase in traffic flow on a short section of road off the existing N15.

Based on EPA Air Quality Monitoring Data for similar sized towns in Ireland, conservative background concentrations for NOx, NO_2 and PM_{10} in this residential area of 25 $\mu g/m^3$, 20 $\mu g/m^3$ and 20 $\mu g/m^3$ respectively have been used in the DMRB Screening Assessment. A 'Do Nothing' and 'Do Something' scenario in 2017 have been investigated based on an existing traffic flow of 3,200 AADT and a future traffic flow of 6,900 with 5% HGV.

No exceedance of the Air Quality Standard Regulations 2011 (S.I. No. 180 of 2011) is predicted to occur with Options 03, 04, 10 & 11, other than a potential slight exceedance of the NOx limit for the protection of ecosystems.

9.5.4.2.3 *Impacts on sensitive ecosystems*

Route options 01A/01B and 02A/02B are adjacent to Cummeen Strand/Drumcliff Bay Special Area of Conservation (SAC) and Cummeen Strand Special Protection Area (SPA). Route options 01A/01B and 02A/02B will follow the existing N15 in proximity to these designated areas and there will not be an increase greater than 5% additional traffic volume on the Route options 01A/01B and 02A/02B in this area. All route options are in close proximity to the Ben Bulben, Gleniff and Glenade Complex SAC and the Crockauns/Keelogyboy Bogs NHA. As there will not be a greater than 5% additional traffic volume on the route options in this area, there will be no significant impact from the development on designated sites in the study area.

9.5.4.2.4 *Summary of the assessment and conclusions*

The prevailing air quality in the study area is mainly impacted by traffic flows and residential, commercial and industrial activities. The prevailing westerly wind from the Atlantic ensures that the area experiences low background air pollutant concentrations with no exceedance of the the Air Quality Standard Regulations.

Table 9-20 outlines the preference ranking from an Air Quality perspective. This assessment is based on the three elements of Route Corridor Selection outlined in *Guidelines for the Treatment of Air Quality in National Road Schemes during the Planning and Construction of National Road Schemes (Revised May 2011)*.

Table 9-20: Summary of Feasible Route Options (Air Quality)

Section	Feasible Route Option												
	1A	1B	2A	2B	3	4	5	6	7	8	9	10	11
South	4	4	4	4	4	4	2	3	3	3	3	4	4
Central	3	3	3	3	3	3	3	3	3	3	3	3	3
North	3	3	3	3	3	3	3	3	3	3	3	2	2
Overall	4	4	4	4	3	3	2	3	3	3	3	3	3

9.5.5 Agricultural Property

9.5.5.1 Outline

The Agricultural Assessment was undertaken by John Bligh & Associates. The report in full is provided in Volume 3, Part A, of the Route Selection Report.

9.5.5.2 Assessment

The route options appraisal comprises of a quantitative and qualitative assessment of agricultural property for each route option. These assessments are based on direct impacts from the alignment of Feasible Route Options and include an allowance of a 10m offset from the extents of the alignment to allow for detailed drainage and earthworks design (This offset does not include for parallel access tracks, or direct access arrangements which will be determined at the next stage of the design process – it is considered in effect, that such arrangements will be broadly similar for each Feasible Route Option).

A further assessment was conducted within 10-30m of the extents of the alignment to identify potential significant direct impacts. For online sections of Route Options 01A/01B and 02A/02B, a detailed design is available and the assessment was based on the extents of the alignment.

For agricultural property, each Feasible Route Option was evaluated in terms of:

- Agricultural landtake;
- Land use;
- Land quality;
- Land impact / land severance;
- Impact on farmhouses and farmyards; and
- Key agricultural enterprises.

Agricultural landtake is based on the length of the route corridor and indicative cross section width for the relevant road type. For landtake purposes, an indicative cross section width of 50.0m is taken for a Type 2 Single Carriageway (inclusive of 1 No. 6m access accommodation track) at Route Selection stage.

The land use and land quality assessments are carried out as a desktop study of digital satellite imagery using the 10m offset from the extents of the Feasible Route Options. Agricultural land along this route corridor was evaluated for each Feasible Route Option.

Landownership information on land and property within the study area allowed for an assessment of impact and land severance for agricultural property on each Feasible Route Option. Farm holdings were individually assessed for agricultural impact based on landtake, land severance and effects on

farm house and farm yards. The criteria for agricultural impact on farm holdings are presented in Table 9-21.

Table 9-21: Agricultural impact criteria on farm holdings

Impact	Criteria
High	Landtake may involve a significant portion of the plot or holding. and / or Land severance may split the holding in two resulting in a significant area becoming inaccessible or landlocked. Mitigation of access involving the provision of accommodation structures may be required. and / or Impact on farm house and / or farmyard buildings.
Medium	Landtake represents a sizeable reduction in the agricultural area. and / or Land severance of a significant area although large enough to continue to be farmed in a productive manner. There may be operational difficulties when moving livestock or machinery. Mitigation of access to existing or severed areas may be required. and / or Impact on farmyard area or animal handling facilities.
Low	Landtake is a relatively small portion of the affected holding. This may involve areas along the external or roadside boundary. and / or No land severance or severance of a relatively small portion of land. Mitigation of access to existing or severed areas may be required. No impact on farm house, farmyard or farm facilities.

A quantitative assessment of the farm houses and farmyards directly impacted by each route option alignment was carried out as a desktop study of digital satellite imagery using the 10m offset from the earthworks extents of the Feasible Route Options.

A quantitative assessment was carried out for key agricultural holdings with farm enterprises considered most sensitive to a new road development. In the case of the N16 Route Selection, these key agricultural enterprises consist mainly of dairy enterprises and in some cases beef, or other farm enterprises. Dairy farms, as intensively operated grassland farms, are particularly sensitive to significant landtake and severance impacts that may adversely affect daily livestock movements and farm milk production.

There are a small number of key dairy farms identified within the study area.

The impact assessment ranking and selection of preferences for Feasible Route Options are based on the criteria as presented in Table 9-22.

For the Southern section of the study area, the impact on agricultural property was deemed to be Moderate Negative on Feasible Route Options 01A resulting in a Medium preference. The impact was deemed to be Major on the remaining options with a Low preference on FRO 07 (incl. a high impact on 2 farm holdings and a medium impact on a key dairy enterprise), 08 (incl. a high impact on 6 farm holdings and a medium impact on a key dairy enterprise) and 09 (incl. a high impact on 5 farm holdings and a medium impact on a key dairy enterprise), and a Very Low preference on FRO 02A (incl. a high impact on 1 farm holding, and high impacts on 2 key dairy enterprises), 02A/B (as per 02A), 03 (incl. a high impact on 1 farm holding, and a high impact on a key dairy enterprise), 04

(incl. a high impact on a key dairy enterprise), 05 (incl. a high impact on 2 farm holdings, and a high impact on a key dairy enterprise) and 06 (as per 05).

For the Central section, the impact on agricultural property was deemed to be Major Negative on all options resulting in a Low preference rank for options 04, 08 and 09, and a Very Low preference rank for all other options. These rankings are generally as a result of high impacts on farm holdings including landtake, severance, farm houses and farm yards.

On the Northern section, the impact on agricultural property was deemed to be Moderate Negative on options 01A, 01A/B, 02A, 02A/B, 03, 04, 07, 08, 09 and 11 resulting in Medium preference ranks. Major Negative impacts were predicted against options 05 (incl. high impacts on 3 farm holdings including impacts on farm houses and farm yards), 06 (as per 05) and 10 (incl. high impacts on 3 farm holdings, including 1 impact on farm houses and farm yards) resulting in Low and Very Low preference ranks.

Table 9-22: Impact assessment criteria for Feasible Route Options

Impact	Preference	Criteria
Major Negative	Very Low Preference	Land use is primarily grass or arable based. Land quality is primarily good being suited to intensive agricultural production and a wide range of agricultural uses. Impact / land severance is predominantly High. Impact on a high number of farmhouses and farmyards. Highly Significant impact on one or more sensitive farming enterprises, i.e. dairy, equine, etc.
	Low Preference	Land use is primarily grass or arable based. Land quality is primarily good being suited to intensive agricultural production and a wide range of agricultural uses. Impact / land severance is predominantly Medium to High. Impact on a medium to high number of farmhouses and farmyards. Moderately Significant impact on sensitive farming enterprises, i.e. dairy, equine, etc.
Moderate Negative	Medium Preference	Land use is mainly grass based with low levels of forestry, rough grassland / scrub. Land quality is average to good and with effective management is suited to intensive agricultural production and a wide range of agricultural uses. Impact / land severance is predominantly Medium. Impact on a low number of farmhouses and farmyards. Slight or Not Significant impact on sensitive farming enterprises, i.e. dairy, equine, etc.
Minor Negative	High Preference	Land use is grass based with medium levels of forestry, rough grassland / scrub. Land quality is primarily average being less suited to intensive agricultural production. Lands are limited in the range of agricultural use. Impact / land severance is Low to Medium. There are no impacts on farmhouses and farmyards. There are no impacts on sensitive farming enterprises, i.e. dairy, equine, etc.
Neutral	Very High Preference	No effect on agricultural lands.

Impact	Preference	Criteria
Positive	Very High Preference	Not applicable to agriculture.

An overall summary of the assessment of the Feasible Route Options is presented in Table 9-23 and Table 9-24.

Table 9-23: Overall summary of agricultural property assessment

Feasible Route Option	Southern Section		Central Section		Northern Section	
	Impact	Preference	Impact	Preference	Impact	Preference
01A	Moderate Negative	Medium Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
01A / 01B	Major Negative	Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
02A	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
02A/02B	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
03	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
04	Major Negative	Very Low Preference	Major Negative	Low Preference	Moderate Negative	Medium Preference
05	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Major Negative	Very Low Preference
06	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Major Negative	Very Low Preference
07	Major Negative	Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference
08	Major Negative	Low Preference	Major Negative	Low Preference	Moderate Negative	Medium Preference
09	Major Negative	Low Preference	Major Negative	Low Preference	Moderate Negative	Medium Preference
10	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Major Negative	Low Preference
11	Major Negative	Very Low Preference	Major Negative	Very Low Preference	Moderate Negative	Medium Preference

Table 9-24: Agricultural Property - Preference

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	3	5	5	5	5	5	5	4	4	4	5	5
Middle	5	5	5	5	5	4	5	5	5	4	4	5	5
North	3	3	3	3	3	3	5	5	3	3	3	4	3
Overall	4	4	4	4	4	4	5	5	4	4	4	5	4

9.5.6 Flora, Fauna & Fisheries

9.5.6.1 Outline

The Flora, Fauna & Fisheries Assessment was undertaken by RPS Consultants. The full assessment is included in Volume 3, Part B, of the Route Selection Report.

9.5.6.2 Appraisal Methodology;

The approach taken in this report is based on the TII *Guidelines for Assessment of Ecological Impacts of National Road Schemes (NRA, 2009*) and in particular Section 5.3 dealing with a Route Corridor Selection Study.

More specific appraisal methodology is expanded upon in the aforementioned Volume 3, Part B, in terms of:

- Significance;
- Flora & Fauna; and
- Fisheries

9.5.6.3 Assessment of Route Corridor Options;

In terms of potential impacts, there is little significant difference in the route options within the Central and Northern Sections of the Study Area as they are located so close together. This is where most routes pass through alkaline fens (or springs) and woodland habitats and terminate within the SAC. There is a greater divergence in the route options within the Southern Section and therefore a divergence in the level of potential impacts on habitats, flora, fauna and fisheries.

The study assesses each route option in terms of impact on Flora, Fauna & Fisheries. In addition Key Ecological receptors are identified including the following:

- Lugnagall woodland – wetland feature;
- Gortnagrelly woodland - wetland feature;
- Badger setts;
- Crockauns/Keelogyboy Bogs NHA;
- Ben Bulben, Gleniff and Glenade Complex SAC

9.5.6.4 Discussion

9.5.6.4.1 *Designated sites*

Natural heritage policies of the Sligo and Environs Development Plan 2010-2016 and Objectives of the *Sligo County Development Plan 2011-2017* (CDP) seek to *inter alia,* maintain and enhance the conservation values of European sites and NHAs, and require appropriate assessment of all proposed development likely to have a significant effect upon a European site.

Option 10 is the only option which does not have a direct impact upon a SAC. All remaining options have a very small earthworks footprint within the SAC[70], except for option 11 which passes entirely through the SAC.

[70] Although the structure design of the Preferred Route can potentially avoid any direct impact.

All Feasible Route Options pass immediately adjacent to the NHA and also result in direct loss of high value native woodland habitat providing (albeit fragmented) connectivity between woodland on the northern slope of Cope's Mountain and the Drumcliff River corridor to the north of Lugnagall.

The option selected as an emerging preferred route should avoid any direct footprint and impact upon natural habitats within a NHA or a SAC. The direct footprint impacts highlighted in this report occur principally within the roadbed of the N16 in the case of Crockauns/Keelogyboy Bogs NHA and within roadside vegetation and grassland habitat in the case of Ben Bulben, Gleniff and Glenade Complex SAC.

9.5.6.4.2 *Other Key Ecological Receptors*

CDP policies in relation to sites of local nature conservation importance such as Annex I alkaline fen flushes and calcareous spring features seek to minimise the impact of new development on habitats of natural value that are key features of the County's ecological network. Developments likely to have an adverse effect on recognised sites of local nature conservation importance will be required to demonstrate the impacts on the ecological value of the site and will not be approved unless it can be clearly demonstrated that there are reasons for the development that outweigh the need to safeguard the nature conservation value of the site.

The policies require adverse effects as a result of development upon such features to be subject to ecological impact assessment, and to ensure that proposed developments do not adversely affect groundwater resources and groundwater-dependent habitats and species.

Policies in relation to woodland, tress and hedgerows seek to protect and conserve them, to prevent disruption to woodland and hedgerow connectivity in the landscape, and to mitigate by planting additional vegetation to offset any adverse effects of loss of such habitats.

Policies in relation to streams and watercourses seek to protect them and maintain them in an open state, capable of providing suitable habitats for fauna and flora; to discouraging culverting or realignment; and to ensure that an ecological assessment is undertaken for developments with the potential to impact on inland waters.

All feasible route options will likely result in direct or indirect impacts upon groundwater-dependent habitats and species, woodlands, watercourses and hedgerows. Hedgerow loss is unavoidable, and will be mitigated by replacement planting in accordance with TII policy. Alignment re-design is recommended to minimise impacts upon features of ecological connectivity in the landscape.

9.5.6.4.3 *Protected species*

Woodland habitats, particularly when located in proximity to watercourses and when linking townland boundaries, may be of local value for foraging bats. Individual trees conflicting with the emerging preferred alignment may serve as bat roosts.

Otters were not recorded in field survey associated with the preparation of this report, but will likely use watercourses in the study area.

Bat and otters are European protected species and they are protected by the European Communities (Birds and Natural Habitats) Regulations 2011, as amended. Assessment prior to a consent decision being issued is required if any evidence of use of the zone of influence of the proposed road is established.

Badger setts are protected by law. Section 23(5)(d) of the Wildlife Act, 1976 as amended makes it an offence to willfully interfere with or destroy the breeding place of any protected wild animal, including badger.

The fisheries assessment notes the presence of salmonid's in some watercourses. Mitigation to protect the water environment and retain riparian corridors for movement of salmonid species will be required, and is entirely consistent with TII policy.

County Development Plan policies seek to ensure that development does not have a significant adverse impact, incapable of satisfactory mitigation, on any plant, animal or bird species protected by law.

Preliminary design of the emerging preferred route will seek to minimise adverse effects on protected sites and species; and natural habitats including bats, badgers, otters, fens, woodlands, trees and hedgerows, and to seek adequate mitigation and/or compensation for any adverse effects as a result of proposed development.

This approach will avoid significant adverse residual effects upon these ecological features and keep the design of the proposed road scheme in conformity and compliance with County Development Plan policies.

9.5.6.5 Conclusion

9.5.6.5.1 *Flora and Fauna*

The emerging preferred route should avoid significant effects on a European site. Any direct habitat loss within a European site or a NHA should be minimised if avoidance is not feasible.

Several key ecological receptors have been identified including woodland and flush habitats. More detailed survey and subsequent evaluation is required to:

(i) Inform the design of the emerging preferred route; and

(ii) Facilitate a comprehensive ecological impact assessment upon the preferred project at EIA stage.

There are a number of potential groundwater fed wetland sites of interest where it is considered there is a moderate to high likelihood of an Annex I habitat (e.g. Alkaline fen) or Annex I priority habitat (e.g. petrifying spring) being present. Where these are located within 100m of the route options, it is recommended that a survey be undertaken by a botanical wetland specialist to assess the presence of Annex I habitats/ priority habitats and rare/ protected flora species and to assess their conservation value. There are 6 sites recommended for further survey (depending on the route selected) at the next stage of the design process and these are identified in Table 9-25. The full Wetlands report is included within section 11 of Volume 3, Part B.

Table 9-25: Wetland site survey recommendations

Site.	Site name	Grid Ref	Further survey	Feature
10	Lugnagall Flush	G725416	Yes	Site known to support Alkaline Fen/ calcareous spring habitat and rare/ protected bryophytes recorded from vicinity.
11	NE of Lugnagall	G729422	Yes	RPS survey recorded tufa mound (Annex I priority habitat Petrifying springs) and potential calcareous springs. Woodland has potential to support rare/protected bryophytes.
12	S of Collinsford	G718413	Yes	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation
13	E of Drum	G713409	Yes	RPS survey found small area of potential calcareous spring/ alkaline fen vegetation.

Site.	Site name	Grid Ref	Further survey	Feature
14	W of Castlegal	G718409	Yes	RPS survey found potential calcareous spring within area of woodland.
16	Leitrim border	G746428	Yes	Potential for calcareous springs and/ or rare/ protected bryophytes within north-facing wooded ravine. Located within SAC.

In terms of Flora, at Preliminary Option Assessment (Feasible Route Options), Route Option 5 emerges as a very high preference option, followed by option 06 being a high preference option. Route options 01A, 01A/01B 02A, 02A/02B 07, 08 and 09 were considered to be of medium preference, while route option 3 was of low preference. Route options 04, 10 and 11 emerged as very low preferences.

These conclusions are summarised in Table 9-26.

Several key ecological receptors have been identified including badger setts online with some route options. More detailed survey and subsequent evaluation is required to (i) inform the preliminary design of the emerging preferred route; and (ii) facilitate a comprehensive ecological impact assessment upon the preferred project at EIA stage.

A protected mammal survey focusing on bats, badgers and otters should be conducted upon the emerging preferred route.

In terms of Fauna, at Preliminary Option Assessment (Feasible Route Options), Route Option 05 emerges as a very high preference option, followed by option 6 being a high preference option. Route options 03 and 08 were considered to be of medium preference, while route options 4, 7, 9 and 10 emerged as being of low preference. Route options 01A, 01A/01B, 02A, 02A/02B and 11 emerged as very low preferences.

These conclusions are summarised in Table 9-27.

9.5.6.5.2 *Fisheries*

The Doonally River (or Willsborough Stream) is the most vulnerable receptor being the waterbody in which the river corridor is encroached upon by several route options, both in the form of channel crossings and proximity to the river channel.

In this regard routes 01A and 01A/01B emerge as the preferred options with routes 02A/02B, 05 and 06 being the least favoured options. Routes 03, 04, 10 and 11 were considered to be of medium preference, while routes 07, 08 and 09 were of low preference.

At Preliminary Option Assessment (Feasible Route Options), route option 01 emerges as a very high preference option. Route options 03, 04, 10 and 11 were considered to be of medium preference, while route options 07, 08, and 09 were of low preference. Route options 02, 05 and 06 emerged as very low preferences.

These conclusions are summarised in Table 9-28.

Table 9-26: POA Preference (Flora)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	3	4	4	4	4	2	3	4	4	1	5	5
Central	2	2	1	1	3	5	1	1	3	3	4	4	4
North	3	3	3	3	3	3	2	2	1	1	1	4	5
Overall	3	3	3	3	4	5	1	2	3	3	3	5	5

Table 9-27: POA Preference (Fauna)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	4	4	5	5	3	3	1	2	5	3	5	3	3
Central	5	5	1	1	2	4	1	1	3	3	3	4	5
North	3	3	4	4	3	3	2	2	1	1	1	3	5
Overall	5	5	5	5	3	4	1	2	4	3	4	4	5

Table 9-28: POA Preference (Fisheries)

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	1	5	5	3	3	5	5	4	4	4	3	3
Central	3	3	3	3	3	4	3	3	3	3	3	3	3
North	2	2	3	3	3	3	3	3	3	3	3	3	3
Overall	1	1	5	5	3	3	5	5	4	4	4	3	3

9.5.7 Hydrology & Hydrogeology

9.5.7.1 Outline

The Hydrology and Hydrogeology Assessment was undertaken by Hydro Environmental Consultants. The full assessment is included in Volume 3, Part B, of the Route Selection Report.

9.5.7.2 Appraisal Methodology;

The assessment is undertaken in line with *TII (NRA, 2008) guidelines on procedures for assessment and treatment of geology, hydrology and hydrogeology for national road schemes*. The assessment involved the assessment of each route option using data presented at the constraints study stage to identify potential impacts on water dependent receptors, which include water dependent habitats both surface water and groundwater fed habitats, surface water resources, flooding and flood risk, water quality, groundwater resources including groundwater bodies and aquifers and water abstractions. This assessment highlights those water dependent receptors considered to be at risk from the route options and provides qualitative assessments of potential impact on such receptors.

9.5.7.3 Impact Assessment

The results of the impact assessment process (which is set out in further detail in Volume 3, Part B, is set out in Table 9-29, Table 9-30, Table 9-31. The assessment sub-topics in respect to hydrology were water quality and morphological implications to watercourses, lakes, estuaries and coastal waters and flood impact/risk. The sub-topics in respect to hydrogeology were impacts to hydrogeological features including karst features, groundwater bodies and local groundwater

supplies and also groundwater fed ecological receptors. These were combined to give an overall preference score for hydrology/hydrogeology.

Table 9-29: Stage 1 Route Preferences for Southern Section

Hydrology and Hydrogeology	Route Options												
	01A	01A/01B	02A	02A/02B	03	04	05	06	07	08	09	10	11
Water courses (Flow, water quality and morphology)	2	3	3	3	3	3	3	3	3	3	3	3	3
Flood /impact and Flood Risk	2	3	4	3	5	5	4	4	3	3	3	5	5
Groundwater Resources, water abstractions and hydrogeological features	5	5	3	5	3	3	33	3	4	4	4	3	3
Groundwater dependent Key Ecological Receptors	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.	Nb.
Combined Score value	9	11	10	11	11	11	10	10	10	10	10	11	11
Overall Preference	Med	Low	Med	Low	Low	Low	Med	Med	Med	Med	Med	Low	Low

Table 9-30: Stage 1 Route Preferences for Central Section

Hydrology and Hydrogeology	Route Options												
	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A
Water courses (Flow, water quality and morphology)	3	3	3	3	3	3	3	3	3	3	3	3	3
Flood /impact and Flood Risk	3	3	3	3	3	3	3	3	3	3	3	3	3
Groundwater Resources, water abstractions and hydrogeological features	3	3	4	4	4	3	4	4	4	4	4	4	4
Groundwater dependent habitats	3	3	4	4	4	5	4	4	5	5	5	4	4

Hydrology and Hydrogeology	Route Options												
	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A
Combined Score Value	12	12	14	14	14	14	14	14	15	15	15	14	14
Overall Preference	Med	Med	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low

Table 9-31: Stage 1 Route Preferences for Northern Section

Hydrology and Hydrogeology	Route Options												
	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	01A	11
Water courses (Flow, water quality and morphology)	3	3	3	3	3	3	3	3	3	3	3	4	5
Flood /impact and Flood Risk	3	3	3	3	3	3	3	3	3	3	3	4	4
Groundwater Resources, water abstractions and hydrogeological features	5	5	4	4	4	4	5	5	4	4	4	5	4
Groundwater dependent habitats	4	4	5	5	5	5	5	5	5	5	5	5	5
Combined Score Value	15	15	15	15	15	15	16	16	15	15	15	18	18
Overall Preference	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Very Low	Very Low

9.5.7.4 Conclusions

In respect to the Hydrology/Hydrogeology there is little difference in the potential impact scale between the various route options considered for any of the three sections, with no profound impacts predicted and where significant impacts were identified mitigation measures were also identified that could reduce, or eliminate such impacts to moderate, slight and imperceptible. Significant hydrological and hydrogeological impacts in respect to potential water quality impact of construction runoff on the Glencar Lough (Ben Bulben, Gleniff and Glenade Complex SAC and pNHA), potential significant hydrogeological impacts to the Gortnagrelly petrifying spring Annex I habitat (National ecological importance), the Lugnagall Annex I habitat (National ecological importance) and moderate impact to the Drum East ecological receptor (Local higher value ecological importance) were identified. All other impacts in respect to water quality in receiving rivers and streams, impact to hydrogeological features and local well supplies and flood risk were rated as slight and moderate permanent impacts.

In that respect, the overall rating for the various road options had a limited range varying from medium to low preference with none identified clearly as either High, Very High, or Very Low preferences.

Table 9-32: Preliminary Options Assessment – Part 1: (Hydrology & Hydrogeology) Preferences

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	4	3	4	4	4	3	3	3	3	3	4	4
Central	3	3	4	4	4	4	4	4	4	4	4	4	4
North	4	4	4	4	4	4	4	4	4	4	4	5	5
Overall	3	4	4	4	4	4	4	4	4	4	4	4	4

9.5.8 Soils & Geology

9.5.8.1 Outline

The Soils and Geology Assessment was undertaken by Roughan O'Donovan Consulting Engineers. The full assessment is included in Volume 3, Part B of the Route Selection Report.

9.5.8.2 Appraisal Methodology

The soils and geological impacts of each of the route corridor options in each section were assessed and reported in general accordance with the *NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*, Chapter 3.4.

The majority of the data was collected and assessed in the form of a desk study of available published information, together with additional sources of information. Borehole or geophysical survey data was not considered necessary for the assessment of the alternative route options.

A site reconnaissance was made by Roughan and O'Donovan Consulting Engineers staff on Wednesday & Thursday 17th & 18th February 2016 to identify any particular constraints and geotechnical or geologic risks evident in the study area.

9.5.8.3 Assessment of Route Corridor Options

The comparison and ranking of the route options was divided into three sections; the northern section, the central section and the southern section as indicated on drawing N16-RS-02. The route

options in each section were compared on geotechnical criteria for the length of the Route that passed through or impacted:

(a) cut and fill balance and total earthworks volumes;
(b) made ground, contaminated land and quarries;
(c) soft ground deposits; and
(d) Karst.

Other factors relating to economic geology, rock slope instability and geological heritage are not likely to have differential impact for any of the alternative route corridors and therefore were not ranked.

9.5.8.3.1 *Southern Section*

Cut and Fill Balance was determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 03, 07, 09 and 10 were ranked most favourably as they generally had a surplus of 25 to 40 % of the required fill volume. Route option 05 was ranked as least favourable it has the highest deficit.

The rating for made ground / landfill / quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. Route option 04 passes to the east of Patrick Goggins' historic fill site as indicated on Figure N16-RS-078. This closed landfill is located at the western boundary of the study area.

The rating for soft ground is based on the length of routes that pass through this type of material. All route options cross some length of soft ground in this section. Route options 01A/01B, 02A/02B, 03, 04 and 08 cross between 270m and 440m of soft ground and have been ranked as least favourable in terms of soft ground. Route options 05, 06, 07 and 09 cross between 110m and 180m approximately and have been ranked next favourable in terms of soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification. Route Option 01A passes in close proximity to a number of potential karst areas with the minimum distance from this route option to an identified area of karstification is approximately 30m. Route Option 01A is likely to present the greatest potential risk of encountering areas of karstification and is ranked as least favourable in terms of karst in this case.

9.5.8.3.2 *Central Section*

Cut and Fill Balance was determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 07 and 09 were ranked as the most favourable as they had a surplus of approximately 25 – 40 % of the required fill volume. Route options 01, 02, 03, 04, 05, 06, 10 and 11 were ranked as least favourable as they have notable earthworks deficits.

The rating for made ground, landfill and quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. None of the routes in the central section pass in close proximity to any areas of made ground, landfill or quarry sites which present a risk of contamination. All route options have been given the same rating in this instance.

The rating for soft ground was based on the length of route options that pass through this type of material. In this section, route option 01A, 03 and 04 pass through between 70 and 80m of potential soft ground while route options 07, 08 and 09 do not pass through any soft ground. Route option 9 has been ranked as most favourable in terms of soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification. Two wet depressional areas have been identified, in the central section of the study area and a further one of these areas outside the study area. Route option 04 crosses one of these features. Route option 04 has been ranked as least favourable in this case.

9.5.8.3.3 *Northern Section*

Cut and Fill Balances were determined from MX modelling and they were ranked on the basis that a surplus of 25 to 40% of the required fill volume was preferred. Route options 02 and 07 were ranked as most favourable as they have a surplus of approximately 25 – 40% of the fill requirement. Route options 1, 3, 4 and 11 were marked as the least favourable as they have unfavourable earthworks deficits.

The rating for made ground / landfill / quarries was based on the length of route options that pass through these areas where there may be a risk of contamination. All route options in the northern section pass close to Sean Gilroy's Quarry which holds a licence to accept inert fill. The sites of Sean Gilroy's Quarry and Francis Scanlon's Quarry are unlikely to impact on the proposed routes within this area. All route options have been given the same rating in the northern section.

The rating for soft ground is based on the length of routes that pass through this type of material. In the northern section, route option 10 passes through approximately 145m of blanket peat. None of the other routes in the northern section passed through soft ground.

The rating for karst is based on the length of routes that pass within close proximity to potential areas of karstification. None of the routes in the northern section pass through any areas of suspected karstification, so therefore all routes have been rated the same.

9.5.8.4 Conclusions

9.5.8.4.1 *Southern Section*

Route options 07 and 09 are considered to be the most favourable route options in the southern section as they had favourable earthworks balances and generally passed through shorter lengths of soft ground when compared to other routes. Route options 01 and 05 are considered to be the least favourable as route 01 passes through a potential area of karstification while route 05 has the least favourable earthworks balance.

9.5.8.4.2 *Central Section*

In the central section, the route options that emerged as most favourable were route options 07, 08 and 09. These three route options had the most favourable earthworks balances and they do not pass through any areas of anticipated soft ground. Route option 04 was the least favourable within this section as it had the least favourable earthworks balance; it passes through a wet depressional area associated with karstification and some potential soft ground.

9.5.8.4.3 *Northern Section*

The preferred routes that emerged from the northern section were route options 02A and 07 plus routes 08 and 09 due to these options having the more favourable earthworks balances. All route options were ranked the same in terms of karst, soft ground deposits and made ground, contaminated land and quarries. Route options 01, 03, 04 and 11 emerged as least favourable as they had the least favourable earthworks balances.

9.5.8.4.4 *Overall*

Route options 07, 09 and 08 are ranked equal first and third overall. They generally exhibit favourable earthworks balance with few impacts or risks related to landfill, soft ground or karst. Route option 01A, 01A/01B are the worst ranked options followed by options 03, 04 and 05.

Table 9-33: Soils & Geology – Feasible Route Options Preferences

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	5	3	3	3	3	5	4	2	3	2	3	3
Middle	4	4	4	4	4	5	4	4	1	2	1	4	4
North	4	4	2	2	4	4	3	3	2	2	2	3	4
Overall	4	5	2	2	4	4	4	3	1	2	1	3	3

9.5.9 **Landscape & Visual**

9.5.9.1 Outline

The Landscape and Visual Assessment was undertaken by RPS Consultants. The full assessment is included in Volume 3, Part C of the Route Selection Report.

9.5.9.2 Assessment

9.5.9.2.1 *Landscape Impacts*

The negative landscape impacts arising from the options in the study area relate to the quality and sensitivity of the landscape areas affected. It is the key characteristics of each landscape area crossed that influences the route selection process. The different Landscape Characters are set out in summary format in section 5.3.2.3 of this report. This category assesses the options both within the existing landscape character described above and as set out in Figure N16-RS-081. Using both the predicted landscape sensitivity and the preliminary road design drawings, the impacts of each option have been appraised and are outlined in summary format below.

Table 9-34: Landscape Character Impact Summary Overview

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
Option 01A				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	Medium	Moderate/ Significant Negative
Option 01A/01B				
Southern	Sligo Lowland Agricultural LCA	Medium	Medium	Moderate Negative

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	Medium	Moderate/ Significant Negative
Option 02A				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 02A/2B				
Southern	Sligo Lowland Agricultural LCA and Sligo Urban LCA	Medium & Low	Medium	Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 03				
Southern	Sligo Lowland Agricultural LCA and Sligo Urban LCA	Medium & Low	High	Moderate/ Significant Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	Medium	Moderate/ Significant Negative
Option 04				
Southern	Sligo Lowland Agricultural LCA and Sligo Urban LCA	Medium & Low	High	Moderate/ Significant Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	High	Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 05				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA	Medium & High	Medium	Moderate/

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
	and Glencar Valley LCA			Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 06				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 07				
Southern	Sligo Lowland Agricultural LCA	Medium	Medium	Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 08				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 09				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 10				
Southern	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	High	Significant Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA and Copes Upland Mountain LCA	High	High	Profound Negative
Option 11				
Southern	Sligo Lowland Agricultural LCA	Medium & High	High	Significant Negative

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
	and Glencar Valley LCA			
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Profound Negative

9.5.9.2.2 *Visual Impact*

The assessment of visual impacts upon residential properties has been based upon a desktop quantitative analysis of sensitive receptors within 300m of the centre line of each option. In addition, the visual envelope for each route has also been established.

Additional assessment of visual intrusion and obstruction on an individual property basis is not required at the option appraisal stage and more detailed assessment is carried out at the full Environmental Assessment stage. The calculation of overall impact, as outlined below, is based on the multiplication of the number of dwellings by 3, 2, 1 or 0.5 reflecting the severity of impact within 50 m, 50-100 m, 100-200 m and 200-300 m respectively.

Table 9-35: Index for Visual Impact on residential properties – Southern section

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index	Visual Impact Ranking
Option 01A	45	16	11	9.5	53	81.5	2
Option 01B	201	176	189	113.5	571	679.5	13
Option 02A	12	40	69	46.5	186	167.5	7
Option 02B	141	180	231	127	622	679	12
Option 03	144	164	145	62	399	515	9
Option 04	138	172	147	59.5	398	516.5	10
Option 05	6	40	27	4.5	58	77.5	1
Option 06	24	42	25	11.5	77	102.5	6
Option 07	24	46	17	8.5	65	95.5	5
Option 08	15	26	35	9	71	85	3
Option 09	15	32	35	4	64	86	4
Option 10	135	164	151	59.5	397	509.5	8
Option 11	147	162	148	60.5	399	517.5	11

Table 9-36: Index for Visual Impact on residential properties – Central section

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index	Visual Impact Ranking
Option 01A	0	8	4	1.5	11	13.5	3=

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index	Visual Impact Ranking
Option 01B	0	8	4	1.5	11	13.5	3=
Option 02A	0	4	9	0	11	13	1=
Option 02B	0	4	9	0	11	13	1=
Option 03	3	4	8	0.5	12	15.5	7=
Option 04	0	6	10	2	17	18	10
Option 05	3	2	9	0	11	14	5=
Option 06	3	2	9	0	11	14	5=
Option 07	3	16	4	0	13	23	11=
Option 08	3	16	4	0	13	23	11=
Option 09	3	16	4	0	13	23	11=
Option 10	3	4	8	0.5	12	15.5	7=
Option 11	3	4	8	0.5	12	15.5	7=

Table 9-37: Index for Visual Impact on residential properties – Northern section

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index	Visual Impact Ranking
Option 01A	12	6	5	2.5	17	25.5	5=
Option 01B	12	6	5	2.5	17	25.5	5=
Option 02A	15	8	6	5	25	34	10=
Option 02B	15	8	6	5	25	34	10=
Option 03	9	10	3	6	23	28	7
Option 04	12	10	5	5.5	25	32.5	8
Option 05	9	4	8	3.5	20	24.5	3=
Option 06	9	4	8	3.5	20	24.5	3=
Option 07	15	8	5	5.5	25	33.5	9
Option 08	15	8	6	5	25	34	10=
Option 09	15	8	6	5	25	34	10=
Option 10	0	10	5	5	20	20	1
Option 11	0	14	5	5	22	24	2

Table 9-38: Index for Visual Impact on residential properties all routes combined

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index	Visual Impact Ranking
Option 01A	57	30	20	13.5	81	120.5	2
Option 01B	213	190	198	117.5	599	718.5	12
Option 02A	27	52	84	51.5	222	214.5	7
Option 02B	156	192	246	132	658	726	13
Option 03	156	178	156	68.5	439	558.5	11
Option 04	150	188	162	67	440	567	9
Option 05	18	46	44	8	89	116	1
Option 06	36	48	42	15	108	141	3
Option 07	42	70	26	14	103	152	6
Option 08	33	50	45	14	109	142	4
Option 09	33	56	45	9	102	143	5
Option 10	138	178	164	65	429	545	8
Option 11	150	180	161	66	433	557	10

9.5.9.2.3 *Conclusions*

In summary when landscape impacts are considered overall there is a preference for Option 05. The next preferred routes are Option 01A and 06. This is followed by a group of Options 01A/01B, 02A, 03, 08, 09 as third and medium preference. Options 02A/2B, 04 and 07 have a low preference. The least preferred routes are Options 10 and 11.

In summary when visual impacts are considered overall there is a preference for Option 05 which is marginally preferred to Option 01A. The second preferred route is Option 02. The medium preferred routes are Options 06, 10 and 03. There is a low preference for Route Options 01A/01B; 02A/02B; 07; 08; and 09. The least preferred route is Option 04.

When landscape and visual impacts are combined there is a preference for Option 05 as it has the lowest visual impact on receptors and is one of the routes with least potential landscape impact. Option 01A is marginally second in preference to Option 05 due to potential greater landscape impact. The least preferred options are Options 10 and 11 that have a potential for profound impacts on the Glencar Valley LCA and the Copes Upland Mountain LCA.

Table 9-39: Landscape Overall Preference Rating

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	1	2	1	2	3	3	1	1	2	1	1	4	4
Central	3	3	3	3	1	4	2	2	3	3	3	3	3
North	3	3	4	4	4	4	4	4	4	4	4	5	5
Overall	2	3	3	4	3	4	1	2	4	3	3	5	5

Table 9-40: Visual Overall Preference Rating

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	2	5	3	5	4	4	1	3	3	2	2	4	4
Central	2	2	1	1	3	4	3	3	4	4	4	3	3
North	2	2	3	3	3	3	2	2	3	3	3	1	1
Overall	1	4	2	4	4	5	1	3	4	4	4	3	3

Table 9-41: Overall Preference

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Visual	1	4	2	4	4	5	1	3	4	4	4	3	3
Landsacpe	2	3	3	4	3	4	1	2	4	3	3	5	5
Overall	2	4	3	4	4	5	1	3	4	4	4	5	5

9.5.10 Archaeology & Cultural Heritage

9.5.10.1 Introduction;

The Archaeology and Cultural Heritage Assessment was undertaken by ACSU Consultants. The full assessment is included in Volume 3, Part C, of the Route Selection Report.

9.5.10.2 Description of Feasible Route Options;

The Feasible Route Options are as described in section 7.3 of the Route Selection Report.

9.5.10.3 Appraisal Methodology;

Archaeological heritage is described in *Framework and Principles for Protection of the Archaeological Heritage* by the Department of Arts, Heritage, Gaeltacht and the Islands (1999) as consisting of material remains (whether in the form of sites and monuments or artefacts in the sense of moveable objects) and environmental evidence. Archaeological sites and monuments vary greatly in form and date, examples include earthworks of different types and periods (e.g. early historic ringforts, prehistoric burial mounds), megalithic tombs from the prehistoric period, medieval buildings, urban archaeological deposits and underwater features such as wrecks. Archaeological sites may have no visible surface features; the surface features of an archaeological site may have decayed completely or been deliberately removed but archaeological deposits and features may survive beneath the surface. Such sites may sometimes be detected as crop-marks visible from the air or have their presence indicated by the occurrence of artefact scatters in ploughed land, but in other cases may remain invisible unless uncovered through ground disturbance. Wetland environments (e.g. peat lands) have a high potential to contain archaeological sites (including trackways, field systems, and settlement sites) which are either difficult or impossible to identify from surface examination alone.

The definition of cultural heritage generally refers to an expression of the ways of living developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values. Cultural heritage is often expressed as either intangible or tangible cultural heritage (ICOMOS, 2002). As part of human activity, cultural heritage produces tangible representations of the value systems, beliefs, traditions and lifestyles. As an essential part of culture as a whole, cultural heritage, contains these visible and tangible traces from antiquity to the recent past. Cultural heritage is a wide concept and can be distinguished in: built environment (buildings, townscapes, archaeological remains) natural environment (rural landscapes, coasts and shorelines, agricultural heritage) artefacts (books & documents, objects, pictures).

As part of the archaeological and cultural heritage route selection study, the route options were compared and contrasted in terms of their potential impact to known constraints as identified in the constraints study and during this present study. The selection in terms of archaeology and cultural heritage is based not only on the number of possible impacts but also on the types of sites involved and the degree of impacts to each site. Under such a system, the route option with the least number of apparent impacts is not necessarily selected as the preferred option. An option with a seemingly low number of known constraints along it could impact more significantly on those constraints than other routes which would not make it a favourable choice.

Each route option was assessed and the study area concentrated on the route corridor and an area 200m either side of the route. The distance was measured from the edge of the route to the edge of upstanding archaeological remains (where known). As any route is potentially subject to a deviation, the occurrence of an archaeological site within 10m of the road corridor was considered a direct impact.

This route selection has been carried out in accordance with the TII (formerly NRA) Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes. Research for this route selection study consulted the following sources:

- Record of Monuments and places for County Sligo
- Monuments under State Care Database
- Previous archaeological assessments (The Constraints Study carried out by Irish Archaeological Consultancy Ltd).
- Topographical files of the National Museum of Ireland
- Excavations Bulletin
- Cartographical evidence, Ordnance Survey maps all editions
- Aerial Photographs
- Sligo County Development Plan 2010-2016
- Sligo County Development Draft Plan 2017-2023
- National Inventory of Architectural Heritage (NIAH)
- List of National Monuments in County Sligo

9.5.10.4 Impact Assessment;

The impacts which each route option may have on each individual constraint fall into four main categories, namely Direct, Indirect, Neutral and No Impact. For the Direct and Indirect impacts the severity of the impact is also included and is classified as Profound Negative, Significant Negative, Moderate Negative, Slight Negative, Imperceptible Negative.

Sites classified as neutral or no impact is self-explanatory but sites assigned this impact classification should not be ignored as their positioning within 100m of a route option may have relevance which is unforeseen at this stage (for example, indirect visual impacts may occur in relation to such sites). A Direct Profound Negative impact would involve an individual constraint being physically damaged or destroyed as a result of its location within or on the edge of a proposed roadtake (for the purposes of Route Selection, the landtake line is assumed to be offset 10m from the edge of cut or fill). This classification was assigned to all archaeological constraints of high significance which appeared within or on the edge of a route option as represented on the supplied drawings.

An Indirect impact is one where the constraint itself would not be directly affected by a route option but where a significant impact could still result through indirect means. For example, the visual amenity or setting of a constraint could be severely impacted by the close proximity of a road while the constraint itself would remain physically undisturbed. An Indirect significant impact might also occur where associated features (such as outlying structures associated with a building or subsurface remains associated with an archaeological site) not recognised at this stage of the assessment could be directly affected during the construction of the road. Other indirect impacts include changes to drainage associated with the road, which could cause the degradation of a wetland site; vibration during and after the construction of the road which could destabilise an upstanding site; or a significant increase in airborne pollution which could deteriorate the stone fabric of an upstanding site.

It was a requirement of this study that Key Impacts be identified in relation to the various route options. A Key Impact refers to a site lying on or adjacent to a proposed route which is of known archaeological or cultural heritage value either from available information; from its designation as a Recorded or National Monument protected under the National Monuments legislation; or from its inclusion in the National Inventory of Architectural Heritage.

Each route option was assessed and the study area concentrated on the route corridor and an area 200m either side of the route. The distance was measured from the edge of the route to the edge of upstanding archaeological remains (where known). As any route is potentially subject to some deviation, the occurrence of an archaeological site within 10m of the road corridor was considered a direct impact.

The study area includes Areas of Archaeological Potential (AAP). These can be defined as parts of the landscape that possess the potential to contain archaeological remains due to topography and landscape type such as drumlin belts, rivers, lakes, high defendable ground and bog. Rivers and lakes are a focus for human habitation as they provide an obvious food resource and accessible transport routes. They (along with bogs) also have the potential to preserve organic archaeological deposits or artefacts such as wood or leather, which do not usually survive within the alkaline conditions associated with terrestrial archaeology. Wooden track ways dating to the Bronze Age period and later have been excavated within bog land throughout Ireland. Rivers and lakes may have also played a role in prehistoric ritual, as significant artefacts from the prehistoric periods and into the early medieval period, are often found within river bed deposits.

An examination of bog maps indicates that the landscape of the study area has no recorded raised or blanket bogs. However it contains a number of landscape features including areas of improved and unimproved wetland, small isolated areas of peat deposits and rivers and streams. The majority of the study area consists of a drumlin belt and margins of upland areas, all of which can be considered Areas of Archaeological Potential (AAP). This landscape type has proven to be the focus of human settlement patterns through all periods within the Irish Landscape. This is observed within the central section of the study area where there is a relatively high concentration of recorded ringfort

and enclosure sites. A list of the Areas of Archaeological Potential is included in table form for each route option within the report contained in Volume 3.

The study area also contains twenty townlands. The townland is the smallest unit of territorial organisation in Ireland.

9.5.10.5 Conclusions

9.5.10.5.1 *Introduction*

The route options were examined and considered in terms of the number, degree and type of impacts on known archaeological sites and also their impacts on areas of archaeological potential; principally the upland areas along the northern end of all route options (AAP13 – N16-RS-112) and the glacial landscape with drumlins and ridges to the south (AAP 14 – N16-RS-110). Both of these areas are prime locations for the presence of ringforts. Other areas of archaeological potential considered, included streams, rivers and wetland areas. Using such a method to compare route options means that the option with the least number of identified impacts will not necessarily be chosen as the preferred route.

No one route option could be regarded as entirely favourable in terms of archaeology and cultural heritage. All proposed options encounter a number of confirmed or potential archaeological, architectural and cultural heritage constraints and all travel through a high-potential landscape which is not yet fully understood archaeologically.

In light of the potential for additional subsurface archaeological remains not identified in this report to exist along the route, in particular in the vicinity of rivers, streams, gravel ridges, areas of bogland or marsh and greenfield areas, it may be a recommendation of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs in association with the local authority that blanket assessment be conducted along the entire length of the preferred route prior to commencement of road building. This could involve a large-scale geophysical survey and/or archaeological test trenching along the roadtake with possible underwater surveys of watercourses. These methods have been used on other road schemes in Ireland in the past and would allow for the early detection of previously unrecorded low-visibility archaeological remains. This in turn would allow a programme of archaeological works to be formulated whereby sites could be fully resolved in such a way as to minimise delay to the development.

It should be acknowledged that this report presents a comparison of general rather than absolute route options and is designed to inform the selection of a final route. The routes as they appear on the drawings supplied for the purpose of comparison may not represent a roadtake definitively. The actual road after construction will be of different width to the routes depicted on the drawings and, therefore, may not have the kind of impacts described in this report. For example, a constraint which appears on the edge of a route option as shown on the drawings is assigned a Profound Negative impact for the purpose of route comparison but in reality it is possible that the constraint could actually be avoided by the roadtake itself. In such cases, the impact would then be reduced to Significant Negative, Moderate Negative or Slight Negative impact during the next stage of the assessment process.

9.5.10.5.2 *Underwater Archaeology*

The proposed route options impact on a number of watercourses. Watercourses such as these should be subject to archaeological assessment, both on land and under water, when deemed necessary. Undeveloped land in the vicinity of a natural watercourse could contain archaeological remains relating to temporary and long-term settlement and activities such as food consumption

and industry. Riverbanks and riverbeds could also contain remains of structures such as bridges, fishing weirs and mills as well as artefacts deposited within the water both inadvertently and intentionally.

Just as with areas of potential archaeological significance on dry land, appropriate mitigation may be required along those sections of watercourses which will be impacted on by the development.

9.5.10.5.3 *Significance of Impacts on Identified sites along the Routes*

The significance of impacts table provided in Volume 3, Part C, is a summary of the impact levels on archaeological sites identified along the routes. It should not, however, be regarded as definitive, rather it is an indicator which contributes to a wider judgment based on the individual circumstances of each feature.

Different monument types lend themselves more easily to assessment and it should be borne in mind that this can create a bias in the record, for example an upstanding stone monument such as a fortified house is easier to examine with a view to significance than a degraded enclosure site.

The significance criteria have been based on the following. All recorded monuments listed within the Record of Monuments and Places, being either standing or recorded as enclosures, which may have no surface expression, are considered to be highly significant and therefore any direct impact on such features can be regarded as Profound Negative. Excavations associated with recorded monuments with no surface expression have produced highly significant sites and therefore without further detailed data at this stage we must consider all recorded monuments to be of the same significance if they are being directly impacted upon by any of the route options.

Relatively speaking sites such as Demesnes, Mills, Mill Ponds & Mill Races, which have been identified through cartographic evidence and through limited field work are considered to be of moderate significance because of their current state of overall preservation within the landscape. However it should be noted that demesne landscapes that contain protected structures may have some level of legal protection in terms of being situated within the curtilage of a protected structure.

Sites considered as being of slight significance are sites of vernacular dwellings identified during a review of cartographic evidence, which without detailed field survey may have no or limited surface expression and may be considered of local significance with no statutory protection. A direct impact is classified within this report as a route option that is directly impacting on an identified site or within 10m of the road embankment of any of the proposed route options.

9.5.10.5.4 *Route Preferences*

In terms of the whole length of the route and based on the information available, Routes 03, 05 and 06 are considered to have the least potential impact in terms of Archaeology and Cultural Heritage as outlined above.

However, when dividing the route options into Southern, Central and Northern sections the findings vary from one section to another. The results of the scoring for each section in terms of Archaeology and Cultural Heritage are as follows:

South Section: The south section of routes 03, 05, 06, 10 & 11 are considered to be the most preferred options as their impact on the known archaeological heritage is restricted to the removal of a section of Mill race CHC47 at Rathbraghan (which is considered to be a significant impact) along with moderate impacts on demesne landscapes at Cartron, Rathbraghan and Doonally (CHC56, CHC57, CHC62 & CHC63). Routes 01A and 01A/01B are the least preferred through the southern

section as both involve the total removal of CHC33, an enclosure in *Doonally* townland and the partial removal of CHC6, a ringfort in Kiltycooly.

Central Section: There are 8 routes considered to be of high preference through the central section (02A, 02A/02B, 03, 04, 05, 06, 10 & 11) with one of those routes (Route 4) being of very high preference. Route 4 has no known impacts through this section and the remaining seven high preference routes have an impact on an old road CHC72 and an indirect impact on ringfort CHC11. Routes 01A, 01A/01B, 07, 08 & 09 are all regarded as being of low preference as they all involve the total or significant removal of ringfort CHC11 and Routes 01A, Routes 01A/01B also involve total or significant removal of the megalithic tomb CHC1.

North Section: There is 1 route considered to be of very high preference through the northern section. Route 10 was found to have only one slightly negative impact on CHC 70, a dwelling in Gortnagrelly. There are 6 route options considered to be of low preference: 03, 04, 05, 06, 07, 08 & 09. These routes all involve the partial removal of ringforts CHC8 and CHC27 near the northern end of the scheme. Routes 02A,02A/02B and 11 involve the full removal of ringfort CHC27 which is considered undesirable and routes 01A and 01A/01B involves the removal of both ringforts CHC8 and CHC10 and are therefore considered to be the least preferred routes.

Table 9-42: Sectional Split and Route Preferences

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	5	5	3	3	2	4	2	2	4	4	4	2	2
Central	5	5	2	2	2	1	2	2	5	5	5	2	2
North	5	5	5	5	4	4	4	4	4	4	4	1	4
Overall	5	5	4	4	3	3	2	2	4	4	4	1	3

9.5.11 Architectural Heritage

9.5.11.1 Introduction;

The Architectural Heritage Assessment was undertaken by ACSU Consultants. The full assessment is included in Volume 3, Part C of the Route Selection Report.

9.5.11.2 Description of Feasible Route Options;

The Feasible Route Options are as described in section 7.3 of the Route Selection Report.

9.5.11.3 Appraisal Methodology;

As part of the architectural heritage route selection study, the route options were compared and contrasted in terms of their potential impact to known constraints as identified in the constraints study and during the route selection assessment study. The architectural heritage assessment focuses not only on the number of possible impacts but also on the types of sites involved and the degree of impacts to each site.

9.5.11.4 Impact Assessment;

Section 20 of Volume 3, Part C, provides an outline of impacts. The descriptions of all 13 route options draws attention to all known and potential architectural heritage constraints identified during the studies.

The impacts which each route option, may have on each individual constraint fall into four main categories, namely Direct, Indirect, Neutral and No Impact. For the Direct and Indirect impacts the severity of the impact is also included and is classified as Profound Negative, Significant Negative, Moderate Negative, Slight Negative, Imperceptible Negative.

Sites classified as neutral or no impact is self-explanatory but sites assigned this impact classification should not be ignored as their positioning within 100m of a route option may have relevance which is unforeseen at this stage (for example, indirect visual impacts may occur in relation to such sites). A Direct Profound Negative impact would involve an individual constraint being physically damaged or destroyed as a result of its location within, or on the edge of a proposed roadtake. This classification was assigned to all architectural constraints of high significance which appeared within or on the edge of a route option as represented on the supplied drawings.

An Indirect impact is one where the constraint itself would not be directly affected by a route option but where a significant impact could still result through indirect means. For example, the visual amenity or setting of a constraint could be severely impacted by the close proximity of a road while the constraint itself would remain physically undisturbed. An Indirect significant impact might also occur where associated features (such as outlying structures associated with a building or subsurface remains associated with an archaeological site) not recognised at this stage of the assessment could be directly affected during the construction of the road. Other indirect impacts include vibration during and after the construction of the road which could destabilise an upstanding site; or a significant increase in airborne pollution which could deteriorate the stone fabric of an upstanding site.

It was a requirement of this study that Key Impacts be identified in relation to the various route options. A Key Impact refers to a site lying on or adjacent to a proposed route which is of known architectural heritage value either from available information; from its designation as a Recorded or National Monument protected under the National Monuments legislation; from its inclusion in the National Inventory of Architectural Heritage or from its inclusion in the Record of Protected Structures in the Sligo County Development Plan 2011-2017 and Sligo and Environs Development Plan 2010-2016.

Each route option was assessed and the study area concentrated on the route corridor and an area 200m either side of the route. The distance was measured from the edge of the route to the edge of upstanding architectural remains. The edge of the route, for the purposes of this assessment, was considered to be 10m from the toe (of embankment), or crest (of the cutting) of the proposed works; this provides for an allowance of ancillary infrastructure (such as for example drainage) which has not yet been established at this preliminary stage.

9.5.11.5 Conclusions

9.5.11.5.1 *General Conclusions*

The majority of constraints identified in this report are either recorded structures listed within the National Inventory of Architectural Heritage, or Protected Structures listed within the Sligo and Environs Development Plan with a number of additional structures identified during a cartographic review. Each of the options encounter a number of these sites. It is expected that some of these constraints identified during the cartographic review will be found to be of little actual architectural heritage interest during fieldwork at Environmental Appraisal Stage. However, until this is confirmed, all sites identified must be given equal consideration and avoided where possible when selecting the preferred route. It should also be noted that further investigation in terms of further

fieldwork along the selected route has the potential to identify additional areas of constraint impossible to identify during this study.

If works are to take place in the vicinity of a protected structure, then further architectural assessment should be carried out in advance. This is likely to involve some form of architectural assessment to determine the potential impact of the development on a protected structure or architectural heritage site listed within this report. Items of built heritage recommended for protected status by their inclusion in the National Inventory of Architectural Heritage should also be given particular consideration and avoided wherever possible.

The route options were examined and considered in terms of the number, degree and type of impacts along them. No one route option could be regarded as entirely favourable in terms of architectural heritage. All proposed options encounter a number of confirmed or potential architectural heritage constraints and all travel through a high-potential landscape which is not yet fully understood architecturally.

Any sites to be impacted by the selected route will require a full architectural survey to include a written description of the structure of an equivalent standard to the descriptions contained in the National Inventory of Architectural Heritage. For large sites, where there is more than one structure, it might be appropriate to make separate records of each. A survey of the structure/structures as existing should include plans, sections and elevations and a comprehensive (good quality) photographic survey.

It should be acknowledged that this report presents a comparison of general rather than absolute route options and is designed to inform the selection of a final route. The routes as they appear on the drawings supplied for the purpose of comparison do not represent a roadtake definitively. The actual road after construction may be of different width to the routes depicted on the drawings and, therefore, may not have the kind of impacts described in this report. For example, a constraint which appears on the edge of a route option as shown on the drawings is assigned a Profound Negative impact for the purpose of route comparison but in reality it is possible that the constraint could actually be avoided by the roadtake itself. In such cases, the impact would then be reduced to Significant Negative, Moderate Negative or Slight Negative impact during the next stage of the assessment process.

9.5.11.5.2 *Significance of Identified sites along the Routes*

The significance of identified sites along the various routes draws on the significance of the sites (Local, Regional, National) from the Sligo Development plan (where included) and the National Inventory of Architectural Heritage.

The level of impact on each site has been categorised under the following impacts; profound, significant, moderate and slight / imperceptible.

Profound: An impact that obliterates the architectural heritage of a structure or feature of national or international importance. These effects arise where an architectural structure or feature is completely and irreversibly destroyed by the proposed development.

Significant: An impact that, by its magnitude, duration or intensity alters the character and /or setting of the architectural heritage. These effects arise where an aspect or aspects of the architectural heritage is/are permanently impacted upon leading to a loss of character and integrity in the architectural structure or feature.

Moderate: An impact that results in a change to the architectural heritage which, although noticeable, is not such that alters the integrity of the heritage. The change is likely to be consistent

with existing and emerging trends. Impacts are probably reversible and may be of relatively short duration.

Slight: An impact that causes some minor change in the character of architectural heritage of local or regional importance without affecting its integrity or sensitivities. Although noticeable, the effects do not directly impact on the architectural structure or feature. Impacts are reversible and of relatively short duration. Appropriate mitigation will reduce the impact.

Imperceptible: An impact on architectural heritage of local importance that is capable of measurement but without noticeable consequences

9.5.11.5.3 *Sectional Assessment of Route Options*

In terms of the whole length of the various route options and based on the information available, Route Option 01A is considered to have the least potential impact in terms of architectural heritage as outlined above.

However, when dividing the route options into Southern, Central and Northern sections the findings vary from one section to another. The results of the scoring for each section in terms of Architectural Heritage are outlined in detail in section 20, Volume 3, Part C; the following provides a brief summary:

South Section

The south section of Routes 01A, 07 and 09 are the highest preference as they each have only moderately negative impacts on demesne landscapes, AHC 14, 15, 16 & 17. The impacts are all to the boundaries of the demesnes in areas largely disturbed by previous development. Route Option 8 is the lowest preference through this section as it impacts profoundly on Doonally School (AHC 6) which is a protected structure. Routes 03, 04, 10 & 11 have a significant impact on demesne landscape AHC 15 where the proposed route cuts the demesne in two. Routes 01A/01B, 02A, 02A/02B, 05 & 06 should be avoided if possible due to a significant negative impact on a number of demesnes and other features.

Central Section

Routes 01A, 01A/01B and 04 are of high preference through the Central section with Route 04 having no impact at all on architectural heritage and the other two routes just having a slight impact on bridge AHC 33. All other routes have a significant impact on the same bridge (AHC 33) and are rated as intermediate options. No route through the Central section is considered to have such a negative impact that it should be avoided.

North Section

With the exception of Routes 01A and 01A/01B all routes through the northern section are considered acceptable with Route Option 11 having the highest preference as it has no impacts on the architectural heritage. All other routes impact to some degree on AHC 24, a vernacular structure of probable 19th century date. Routes 01A & 01A/01B involve the total removal of the structure and are considered the least favourable of the route options.

Table 9-43: Sectional Architectural Assessment (Preferences) of Route Options

Section	Refined Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	2	4	4	4	3	3	4	4	2	5	2	3	3
Central	1	1	3	3	3	1	3	3	3	3	3	3	3
North	3	3	2	2	1	1	1	1	1	1	1	1	1
Overall	2	3	3	3	3	2	3	3	2	3	2	3	3

9.5.12 Urban Planning

9.5.12.1 Outline

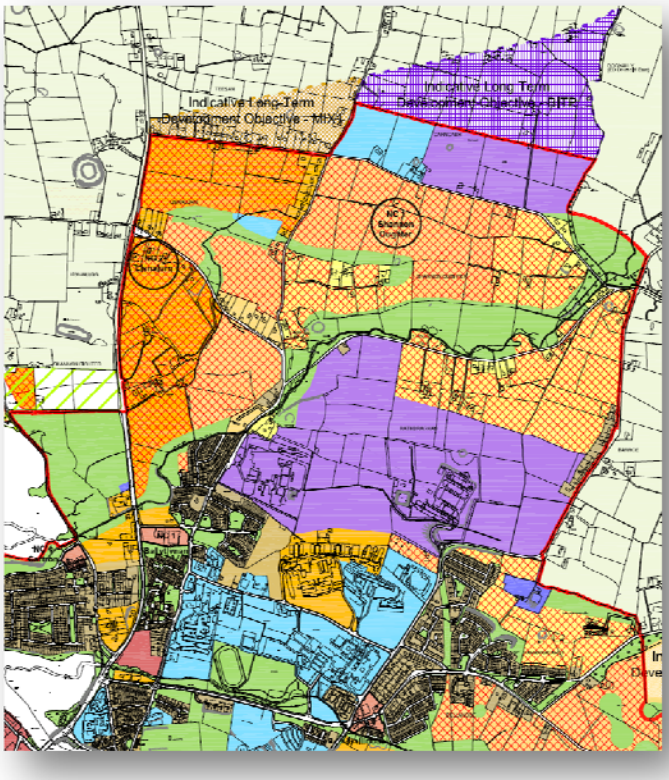
The Urban Planning Assessment was undertaken by The Planning Partnership. The full assessment is included in Volume 3, Part A, of the Route Selection Report.

This assessment is concerned with the Southern section of the study area only.

9.5.12.2 Assessment

The Urban Planning section of the Route Selection report, focuses on the implications of each Route Option on the Sligo & Environs Development Plan 2010-2016 (SEDP) and more particularly on the North Fringe Local Area Plan (LAP) 2010-2016, the assessment also has regard to the Sligo County Development Plan 2011-2017, as varied (Variation no. 2) in October 2011 by the introduction of the Core Strategy.

Figure 9-14: North Sligo Zoning



The SEDP and LAP plan for the long term expansion of Sligo identifies the long term needs over a 10-20 year period.

The LAP identifies a significant land bank of c. 153 hectares in the southern section of the route corridor, which is to accommodate substantial residential development (i.e. accommodating up to 3,280 additional persons) and associated retail, educational, community uses, and a designated business, industry and technology park. In addition a substantial area of land is designated for open space which will form a riverside park as part of a connected network of open spaces throughout the urban area of Sligo.

In addition to the LAP area, lands to the south at Shannon Eighter have been designated for residential and mixed use whilst lands at *Rathbraghan* have been designated for low density residential and business, industry and technology uses. The development of these lands will link the North Fringe area to the existing urban built up area and provide *inter alia* for in the order of 2,096 – 4,148 additional persons over and above the potential population of the LAP area.

North of the LAP area, additional lands have also been identified as mixed use and business, industry and technology use for the longer term, e.g. as a subsequent phase of development to the build out of the North Fringe area.

The combined urban expansion area as noted above is therefore a strategic area for the long term orderly expansion of Sligo. Based on the geographical features of the City there is more limited capacity for expansion to the west of the existing N15 and similarly more limited capacity for expansion to the east of the N16 north of the existing built up area. The area between, is therefore a key area of expansion of the northern environs of Sligo, along with the Hazelwood – Bellanode area.

Substantial additional future development lands have also been identified to the South of the City at *Caltragh-Carrowroe*, and urban regeneration in the Docklands and Cranmore-Cleveragh areas will also deliver considerable additional capacity for population increase.

It is noted however that an appropriate distribution of population increase is necessary to avoid imbalance of the urban area and to ensure the primacy of the City centre as the focal point of the urban area.

The route options can be classified into three categories of Western, Central and Eastern, all within the Southern Area of the Sectional Splits (as defined in section 9.2.1 of this Route Selection Report).

Of particular note, is that the western routes (options 01A, 01A/01B) follow the alignment of the assumed route at the time of preparation of the SEDP and LAP hence these routes would not particularly impact on or affect the implementation of the SEDP and LAP, however it is noted that these routes do not follow the 'desire line' of traffic into / out of the City Centre and immediate environs.

Furthermore, the SEDP envisages a future bypass of the City which would be likely to be developed to the western side of the City. The western routes would be positioned to connect directly into same should it be developed.

As noted above, however, the dominant origin / destination of traffic on the N16 is to the City Centre, hence whilst linkages to any future bypass would be appropriate, the primary role of the N16 to service the City Centre would remain.

In terms of the eastern routes (Options 05, 06, 07, 08 & 09), whilst these were not envisaged at the time of the preparation of the SEDP and LAP they would largely avoid the lands zoned for urban expansion – only quite limited loss of development land would arise.

In terms of the Central routes (options 03, 04, 10 & 11), these generally traverse lands which are planned to be relatively intensively developed over the long term.

Options 05 and 06 are located just westward of the existing route and would avoid splitting the lands zoned for urban expansion though lead to loss of a corridor of development land between the route options and the existing road.

Options 02A and 02A/02B (and its partially shared alignment with Option 03 & 04) would also traverse the area planned to be relatively intensively developed over the long term and would subdivide the expansion area, with considerable ramifications for the planned layout of the area, and would require considerable reconsideration of the future development of the North Fringe LAP area.

In relation to Options 03 & 04, which would also require considerable reconsideration of the future development of the North Fringe LAP area, they would particularly affect the existing / active business, industrial and technology lands at *Rathbraghan*, in that the existing large land bank would be subdivided, in addition to the loss of an amount of land for the purposes of road construction. This could affect the overall development of the area, in that it could prevent the potential clustering of industry over a single area, as the road would likely act as a considerable barrier splitting the area.

The following Table 9-42 illustrates the summary of the 'score card' for each route. As noted previously, this report focuses on the southern section of the route corridor / options.

Table 9-44: Feasible Route Options – Urban Planning Preference

Section	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
South	3	3	4	4	5	5	3	3	2	2	2	5	5

9.6 Stage 1 – Part 1: Preliminary Options Assessment; Conclusion and Options Refinement

9.6.1 **Assessment**

9.6.1.1 Overview

The first stage of the refinement process included an examination of the following:

(1) The 'Preliminary Options Assessment' reports as already outlined in the foregoing sections of this chapter;
(2) The completed scorecards;
(3) Discussions at the Multi Disciplinary Workshop;

The Preliminary Options Assessment' reports informed the scorecard described at (2), which in turn facilitated a number of reviews from differing perspectives including 'Full Scores Compilation' and 'Averaging as per Framework Matrix Criteria'. The outputs from points (1) and (2), facilitated interactive discussions between the Multi Disciplinary Team during the workshop described in section 9.6.1.4.

It is important to note, that the matrices described in the proceeding sections of this report should be interpreted as guiding tools, as opposed to an exact science in terms of comparing individual route options. It is these tools, together with collaborative professional judgement and localised assessment of route impacts which ultimately dictate the refinement and selection of the optimal routes.

9.6.1.2 Full Scores Compilation

The 'Full Scores Compilation' considered each assessment discipline in its own individual right. It sums up the total scores to give a total cumulative score and then applies the ranking structure outlined in Table 9-45.

Table 9-45: Application of Ranks to 'Preferences'

Relative Rank		Preference	Preference Rank
From	To		
1	2	Very High Preference	1
3	4	High Preference	2
5	9	Medium Preference	3
10	11	Low Preference	4
12	13	Very Low Preference	5

9.6.1.3 Averaging as per Framework Matrix Criteria

With cognisance of the fact that there is no weighting applied in the case of the 'Full Scores Compilation' a comparable exercise was carried out which averaged the scores for each discipline under the 'Preliminary Options Assessment' framework categories of; 'Engineering', 'Economy' and 'Environment'. This permitted an additional broad comparable to the 'Full Scores Compilation'.

9.6.1.4 Multi-Disciplinary Workshop

A first Draft of the various multi disciplinary reports was completed in advance of a Workshop held on the 1st of June, 2016. The workshop facilitated interactive discussions in relation to 'Feasible Route Options' and their perceived impacts. It resulted in a general consensus, as to which parts of the various 'Feasible Route Options' should proceed to the next stage of the assessment and where there was a requirement for further localised assessment.

Discussions at the workshop were guided initially by the outputs of the aforementioned Scorecards. This allowed for a more in depth critical analysis of each particular section. The aim was to establish a consensus in relation to which options were less preferable to others, or, if there were situations where some options could be improved via design changes. The opinion's of each particular specialist was provided, with a particular focus on core aspects of the particular studies, i.e. those areas which were expected should, or could, influence the selection of a Preferred Route. Interactive group discussions, focussed generally on the following aspects:

- Initial ranking of route options (in terms of the scorecards);
- Clusters of positive ranks (i.e. 'Very High Preference', 'High Preference' and in some cases the upper ends of 'Medium Preference' ranks);
- Clusters of negative ranks (i.e. 'Very Low Preference', 'Low Preference' and in some cases the lower ends of the 'Medium Preference' ranks);
- Profound, or Significant localised impacts;
- Desirable and undesirable lines; and
- Potential amalgamated, modified options.

The following outlines the assessment results in terms of the south, central and north section splits.

9.6.1.5 South Section

9.6.1.5.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 9-46. In general, options 05, 08 and 09 are the best scoring routes, followed closely by option 07. 'Medium' preference options were considered to be options 01A, 02A, 03, 06, 10 and 11. The worst scores are attributed to options 01A/1B followed closely by 02A/02B and 04. In order to assist in the process of refining routes down, Table 9-47 provides a general overview in relation to 'Very Low Preference' and 'Low Preference' ranks. It is apparent that the majority of these scores occur against options 01A/01B, 04, 02A/02B, 03, 10, 11 and 02A.

Table 9-46: South Section: Full Scores Compilation

Disipine		Feasible Route Option: South Section												
		1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Eng	Traffic	4	4	4	4	1	1	1	3	2	2	2	1	1
	Road Engineering	1	2	2	2	2	2	2	2	2	2	2	2	2
	RSIA (FULL ROUTE)	5	5	3	4	3	4	1	3	1	2	1	3	3
Eco	Options Comparison Est.	1	3	3	3	4	4	2	3	3	1	2	4	4
Environmental	Socio Economic	5	4	4	3	4	4	2	2	3	1	3	4	4
	Non - Agri	4	4	3	3	5	5	3	3	4	4	4	5	5
	Noise & Vibration	4	4	4	4	4	4	2	2	2	2	2	4	4
	Air Quality	4	4	4	4	4	4	2	3	3	3	3	4	4
	Agriculture	3	3	5	5	5	5	5	5	4	4	4	5	5
	Flora	3	3	4	4	4	4	2	3	4	4	1	5	5
	Fauna	4	4	5	5	3	3	1	2	5	3	5	3	3
	Fisheries	1	1	5	5	3	3	5	5	4	4	4	3	3
	Flora, Fauna & Fisheries	1	1	4	4	2	2	4	4	4	2	4	3	3
	Hydro & Hydro Geol	3	4	3	4	4	4	3	3	3	3	3	4	4
	Soils & Geology	3	5	3	3	3	3	5	4	2	3	2	3	3
	Landscape	1	2	1	2	3	3	1	1	2	1	1	4	4
	Visual	2	5	3	5	4	4	1	3	3	2	2	4	4
	Landscape & Visual	2	4	2	4	4	4	1	2	3	2	2	4	4
	Archaeology & CH	5	5	3	3	2	4	2	2	4	4	4	2	2
	Architectural H	2	4	4	4	3	3	4	4	2	5	2	3	3
	Urban Planning	3	3	4	4	5	5	3	3	2	2	2	5	5
Overall Index, Rank and Preference	Overall	50	59	55	58	55	58	42	48	44	42	42	56	56
	STRAIGHT RANKING	6	12	7	11	7	11	1	5	4	1	1	9	9
	Preference	3	5	3	4	3	4	1	3	2	1	1	3	3

Table 9-47: South – 'Very Low Preference' and 'Low Preference' ranks

Discipline	Feasible Route Options												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Traffic	X	X	X	X									
Road Engineering													
RSIA	X	X		X		X							
Options Estimate					X	X						X	X
Socio-Eco	X	X	X		X	X						X	X
Non-Agri	X	X			X	X			X	X	X	X	X
Noise & Vibration	X	X	X	X	X	X						X	X
Air Quality	X	X	X	X	X	X						X	X
Agriculture			X	X	X	X	X	X	X	X	X	X	X
Ecology			X	X			X	X	X		X		
Hydro & Hydro Geology		X		X	X	X						X	X
Soils & Geology		X					X	X					
Landscape and Visual		X		X	X	X						X	X
Archaeology & Cultural Heritage	X	X				X			X	X	X		
Architectural Heritage		X	X	X			X	X		X			
Urban Planning			X	X	X	X						X	X
Totals	7	11	8	10	9	11	4	4	4	4	4	9	9

9.6.1.5.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 9-48. In general, 'Low Preference' scores are seen to be recorded against; options 01A/01B for Engineering and Environment; options 02A and 02A/02B for Environment, and, options 03, 04, 10 and 11 for Economics and Environment. This shows a similar trend when compared against the 'Full Scores Compilation' assessment.

Table 9-48: South Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Engineering Average Rank	3	4	3	3	2	2	1	3	2	2	2	2	2
Economics Average Rank	1	3	3	3	4	4	2	3	3	1	2	4	4
Environment Average Rank	3	4	4	4	4	4	3	3	3	3	3	4	4

9.6.1.5.3 *Workshop Discussions*

Workshop discussions in relation to the South section were focussed mainly on 2 principal aspects; firstly the demand requirements of the N16 traffic, and secondly on the environmental aspects associated with the various route options. At a strategic level, the results of the Traffic Model provided a calculated assessment of how traffic would be attracted to various destination points from the N16.

The results showed evidence, that approximately 30% of traffic coming from the north in the case of options 01A/01B and 02A/02B would be attracted off the proposed routes at their junction's with the Drum Road (L-3406-0). In addition, the model showed in the case of the foregoing options and Option 03 (including also Options 04, 10 and 11) that there is a significant pull of traffic (upwards of 85% of the traffic which remains on the routes following its intersection with the Drum Road) off the FRO's to the L-9005-0 (Ballytivnan Road), either at their junctions with this road itself, or via the L-7421-0 and L-7422-0. There are a number of consequences arising from this, including:

(1) A resulting inefficiency of the particular 'Feasible Route Option'; and
(2) An indirect impact on the local networks in terms of *inter-alia* amenity, noise & vibration and air quality.

Actions and Recommendations arising from the workshop are broadly surmised in section 9.6.1.5.4.

9.6.1.5.4 *South Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the 'Preliminary Options Assessment' and the subsequent workshop.

Discount Options

The following outlines options which were recommended to be discounted, at this stage of the 'Preliminary Options Assessment'.

Options 03, 04, 10 and 11

It was recommended that the strategic options to the south which comprise options 03, 04, 10 and 11 should be discounted. The reasons for this include:

- Impacts in relation to Urban Planning and the zoning objectives of the Sligo & Environs Development Plan;
- Non-Agri Property impacts including impacts on lands with significant development potential;
- Agricultural Property impacts including impacts on a Key Dairy Enterprise;
- Noise and Vibration Impacts as a result of increased traffic flows in the Ballytivnan Area;
- Air Quality Impacts as a result of increased traffic flows in the Ballytivnan Area;
- Hydrology impacts including the potential impacts on an area of Floodplain Storage;
- The east/west local connectivity of these options could be tested, via the utilisation of the east/west link as an additional element of options which tie into the AbbVie Roundabout; and
- There is an absence of significant design mitigation measures available to reduce the impacts arising from these options.

Option 06

It was recommended that option 06 be discounted for the following reason:

- It has a similar arrangement to option 05 with the exception of a double roundabout system to the south. Arising from the Traffic Model assessment, this alternative arrangement has the effect of increasing journey times on option 06, over option 05, with the resulting effect that some of the traffic will divert to the local network. For this reason, it is considered that option 05 is more preferable to option 6 in a direct comparison.

Options 07 and 09

In terms of the 'Preliminary Options Assessment' and from an 'Environmental' perspective, FRO's 07, 08 and 09 appear from the viewpoint of the scorecards to achieve overall the best results; they do however each provide very similar strategic objectives. In this regard, a direct comparison was carried out on each of these options.

In the case of options 07 and 09, there is little room to manoeuvre design changes which will further reduce impacts on existing residential properties; however, in the case of option 08, it was considered that potential existed to modify the design in order to achieve a physical clearance of circa 8-10m from AHC 06, which is a protected structure and an existing Alzheimer's Day Care Unit.

It was therefore agreed, to undertake the foregoing assessment, prior to making an informed decision on the viability of these options. The resulting conclusion was that such a change was possible and should in this regard be considered as a modified alternative to FRO 08, additionally it was also established that the southern portion of this route could be amalgamated with the southern tie in alignment of option 07, thereby reducing impacts on agricultural property. A Grade 1 Architectural assessment was undertaken on the aforementioned protected structure; this provided recommendations which could be applied in the 'Design' Phase which may reduce impacts on the curtilage and setting of the structure, in addition and notwithstanding the legal nature of the protected status of the structure, this assessment observed the following in relation to the structure itself:

> *The significance of the former Dunally School is primarily of social interest although there are also surviving ventilation features at the building that may be of scientific interest. There is little of interest from an architectural heritage perspective, except the picturesque accumulation of several periods of development. There is no single period of historic development that has survived completely intact and many original features have been removed...*

Based on the results of the foregoing, it was considered that options 07 and 09 provided higher negative impacts (particularly in relation to domestic property) than the modified version of option 08. In this regard, it was proposed that they be discounted from the process.

Design Modifications

The following outlines options which have been recommended to undergo design modifications and in this regard be subjected to further assessment (Section 10).

Options 01A, 01A/01B, 02A, 02A/02B

As already outlined in the preceding text and tables, there are notable impacts associated with options 01A, 01A/02B, 02A and 02A/02B, however it is apparent from the 'Preliminary Options Assessment' and discussions at the subsequent workshop that it may be possible to mitigate some of these impacts by alternative designs, which effectively would reduce the volume of additional traffic being attracted to the local network from the national network. In this regard, given the strategic nature of these options, it was considered that it would be inappropriate to discount them without extending the assessment. The extended assessment will consider the benefits of:

- Establishing modified designs, which separate the National and Local Network on the approaches to Sligo – i.e. modification of the vertical design to provide road underbridges;

Option 08

As already referred to, the modified version of option 08 is generally considered a desirable option. However, considering noticeable alignment design changes and for reasons for clarity and ease of assessment, it is considered that this modified design would be more appropriately considered in a re-labelled situation as option 12.

Option 12 (Amalgamated Option)

An amalgamated design option has been developed in the 'South Section' arising from the 'Preliminary Options Assessment' and the subsequent discussions at the Multi Disciplinary Workshop. This option utilises aspects of option 07 (tie in to the AbbVie Roundabout) and modified aspects of option 08 (Horizontal alignment change) at *Faughts* townland.

Option 13 (Amalgamated Option)

As referred to already, the east/west link previously considered under options 03, 04, 10 and 11, will progress to the next stage of the assessment as a potential supplementary addition to the options which tie into the AbbVie roundabout.

Proceed to next stage of Assessment

Option 05

In the South section, it was acknowledged that option 05 does provide negative impacts which could be conceived to be of a higher magnitude (than other options in the South) in relation to some environmental aspects including Agriculture property (impacts on a key dairy enterprise) and Architectural Heritage (impacts on a demesne and visual setting impacts to a protected structure). However; considering the routes shorter nature in comparison to option 08 which also ties into the AbbVie Roundabout, it was considered that the economic benefits should be more accurately measured and then balanced against the environmental impacts before proceeding to make a

decision on the route option. In this regard, it was recommended that option 05 should proceed to the next stage of the assessment.

Summary

In general the foregoing sets out, the status of the various routes following the 'Preliminary Options Assessment'. Table 9-49 provides a summary of this status.

Table 9-49: South Section - Recommendations arising from Preliminary Options Assessment and from Multi Disciplinary Workshop [71]

Feasible Route Option	Recommendation
01A	Modify Design and Re-appraise in Stage 1, Part 2 (Rename 1A - v2)
01A/01B	Modify Design and Re-appraise in Stage 1, Part 2 (Rename 1A/B - v2)
02A	Modify Design and Re-appraise in Stage 1, Part 2 (Rename 2A - v2)
02A/02B	Modify Design and Re-appraise in Stage 1, Part 2 (Rename 2A/B - v2)
03	Discount based on POA, SC and WD.
04	Discount based on POA, SC and WD.
05	Proceed to Stage 2
06	Discount based on POA, SC and WD.
07	Discount based on POA, SC and WD and actions. Although south tie in is included in Opt 12.
08	Modify Design and Re-appraise in Stage 1, Part 2 as option 12 (New)
09	Discount based on POA, SC and WD and actions.
10	Discount based on POA, SC and WD.
11	Discount based on POA, SC and WD.
12 (New)	Amalgamated Design Option' targets desire lines from **FRO 07 and 08**

9.6.1.6 Central Section

The Central section contains a number of alignments which are coincidental. In summary, these alignments can for the purposes of brevity be grouped as follows:

(1) Options 01A and 01A/01B;

(2) Options 02A, 02A/02B;

(3) Option 03 (which is broadly similar to option 02A but with minor modifications to the north);

(4) Option 04;

[71] Abbreviations in Table include:

POA: Preliminary Options Assessment;

SC: Score Card;

WD: Workshop Discussions.

(5) Options 05 and 06;

(6) Options 07, 08 and 09;

(7) Options 10 and 11.

The underlined option will be discussed for the purposes of this report.

9.6.1.6.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 9-50. In general, options 05 and 06 are the best scoring routes, followed closely by options 02A, 02A/02B, 08 and 09. Medium preference routes are considered to be options 03, 04, 07, 08, 10 and 11, while the worst scoring routes are considered to be options 01A and 01A/01B. In order to assist in the refinement process, Table 9-51 provides a general overview in relation to 'Very Low Preference' and 'Low Preference' ranks. It is apparent that the majority of these scores occur against options 04 and 01A.

Table 9-50: Central Section Full Scores Compilation

Disipine		Feasible Route Option: Central Section												
		1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Eng	Traffic & Transport	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Engineering	1	1	1	1	2	2	2	2	1	1	1	2	2
	RSIA	0	0	0	0	0	0	0	0	0	0	0	0	0
Eco	Options Comparison Est.	5	5	4	4	3	3	2	2	2	1	1	3	3
Environmental	Socio Economic	5	5	3	3	3	4	2	2	2	2	2	3	3
	Non - Agri	5	5	2	2	2	2	2	2	3	3	3	2	2
	Noise & Vibration	2	2	3	3	3	4	3	3	4	4	4	3	3
	Air Quality	3	3	3	3	3	3	3	3	3	3	3	3	3
	Agriculture	5	5	5	5	5	4	5	5	5	4	4	5	5
	Flora	2	2	1	1	3	5	1	1	3	3	4	4	4
	Fauna	5	5	1	1	2	4	1	1	3	3	3	4	5
	Fisheries	3	3	3	3	3	4	3	3	3	3	3	3	3
	Flora, Fauna & Fisheries	3	3	2	2	3	4	2	2	3	3	3	4	4
	Hydro & Hydro Geol	3	3	4	4	4	4	4	4	4	4	4	4	4
	Soils & Geology	4	4	4	4	4	5	4	4	1	2	1	4	4
	Landscape	3	3	3	3	1	4	2	2	3	3	3	3	3
	Visual	2	2	1	1	3	4	3	3	4	4	4	3	3
	Landscape & Visual	3	3	2	2	2	4	3	3	4	4	4	3	3
	Archaeology & CH	5	5	2	2	2	1	2	2	5	5	5	2	2
	Architectural H	1	1	3	3	3	1	3	3	3	3	3	3	3
	Urban Planning	0	0	0	0	0	0	0	0	0	0	0	0	0
Overall Index, Rank and Preference	Overall	45	45	38	38	39	41	36	36	40	39	38	41	41
	STRAIGHT RANKING	12	12	3	3	6	9	1	1	8	6	3	9	9
	Preference	5	5	2	2	3	3	1	1	3	3	2	3	3

Table 9-51: Central Section – 'Very Low' Preference and 'Low' Preference ranks

Discipline	Feasible Route Options												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Traffic	-	-	-	-	-	-	-	-	-	-	-	-	-
Road Engineering		-		-				-	-		-		-
RSIA	-	-	-	-	-	-	-	-	-	-	-	-	-
Options Estimate	X	-	X	-				-	-		-		-
Socio-Eco	X	-		-		X		-	-		-		-
Non-Agri	X	-		-				-	-		-		-
Noise & Vibration		-		-		X		-	-	X	-		-
Air Quality		-		-				-	-		-		-
Agriculture	X	-	X	-	X	X	X	-	-	X	-	X	-
Ecology		-		-		X		-	-		-	X	-
Hydro & Hydro Geology		-	X	-	X	X	X	-	-	X	-	X	-
Soils & Geology	X	-	X	-	X	X	X	-	-		-	X	-
Landscape and Visual		-		-		X		-	-	X	-		-
Archaeology & Cultural Heritage	X	-		-				-	-	X	-		-
Architectural Heritage		-		-				-	-		-		-
Urban Planning		-		-				-	-		-		-
Totals	6	-	4	-	3	7	3	-	-	5	-	4	-

9.6.1.6.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 9-52. In terms of Engineering and Environment, there is only a marginally distinguishable difference between the various route options. Arising from the Options Comparison Estimates, the Economics section shows options 01A and 02A to be more expensive options.

Table 9-52: Central Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Engineering Average Rank	1	1	1	1	2	2	2	2	1	1	1	2	2
Economics Average Rank	5	5	4	4	3	3	2	2	2	1	1	3	3
Environment Average Rank	4	4	3	3	3	3	3	3	3	3	3	3	3

9.6.1.6.3 *Workshop Discussions*

Workshop discussions in relation to the Central section were focussed predominately on Environmental impacts. In general, it was noted that there were negative impacts on people, arising from a number of differing route options. Of most significance, is this regard was impacts arising from option 01A. Impacts were generally observed to increase in significance as route options moved away from the existing N16, such as for example in the case of option 04. There were notable impacts also discussed, which due to their isolated nature did not get fully reflected in the score cards, this includes for example impacts on agricultural (including farm house) property in the townland of *Lugatober* – it was also recommended that these impacts if possible should be avoided. In addition, notable discussions also took place around the avoidance of potential impacts on Groundwater Dependent ecosystems such as at Lugnagall Flush.

It was generally agreed that the design approach to achieve an optimal solution should be one which maintains proximity as far as possible to the existing N16.

9.6.1.6.4 *Central Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the 'Preliminary Options Assessment' and the subsequent workshop.

Discount Options

The following outlines options which have been recommended to be discounted following the 'Preliminary Options Assessment'.

Option 01A

It was recommended that option 01A should be discounted for the following reasons:

- Negative impacts arising, in relation to Non-Agricultural and Agricultural property aspects.

Option 02A and 03

It was recommended that options 02A and 03, be discounted for the following reasons:

- Negative impacts arising, in relation to Agricultural property aspects, including impacts on a dwelling associated with farm property.

However, as an alternative comparable, it was considered that the junction arrangement proposed as part of these options and occurring in *Collinsford/Lugnagall*; should be retained for the next stage of the assessment process.

Option 04

It was recommended that option 04 be discounted for the following reasons:

- Impacts arising in relation to *inter-alia*; Flora, Hydrology and Hydro Geology, Noise & Vibration and Landscape & Visual.

Similar to options 02A and 03, it was proposed that the proposed junction arrangement (at *Collinsford/Lugnagall*) should be considered further.

Option 10

It was recommended that option 10, be discounted for the following reasons:

- Negative impacts arising, in relation to Agricultural property aspects, including impacts on a dwelling associated with farm property.

However, the northern portion of option 10 (including the proposed junction arrangement at *Collinsford/Lugnagall*) will be considered further as a modified design option.

Design Modifications

Option 08

Arising from the 'Preliminary Options Assessment', it was recommended that option 08 should progress to the next stage of the assessment. However, it was considered given the difficulty in establishing junction arrangements in *Collinsford/Lugnagall* that an alternative solution should be considered as part of a modified option 08 – this is in cognisance of the undesirable junction arrangement initially proposed. This modified design involves bridging the L-3404-0 in an underbridge arrangement.

Option 12 – Amalgamated Option

An amalgamated design option has been developed in the 'Central Section' arising from the 'Preliminary Options Assessment' and the subsequent discussions at the Multi Disciplinary Workshop. This option is based on desire lines generally following amalgamated sections of options 05 and 10. As part of this option, 3 separate junction arrangements will be considered in *Collinsford/Lugnagall*.

Retain Design

Option 05

It was recommended that option 05 should progress to the next stage of the assessment.

Summary

In general the foregoing sets out, the status of the various routes following the 'Preliminary Options Assessment'. Table 9-53 and Table 9-58 provide a summary of this status.

Table 9-53: Central Section - Recommendations arising from Preliminary Options Assessment and from Multi Disciplinary Workshop [72]

Feasible Route Option	Recommendation
01A	Discount based on POA, SC and WD. South section modified to tie in with Opt 08.
01A/01B	Discount based on POA, SC and WD. South section modified to tie in with Opt 08.
02A	Discount based on POA, SC and WD.
02A/02B	Discount based on POA, SC and WD.
03	Discount based on POA, SC and WD. But, include junction arrangement at *Lugatober* as alternative.
04	Discount based on POA, SC and WD.
05	Proceed to Stage 2.
06	As per Opt 05.
07	As per Opt 08.
08	Modify Design to pass over the L-3404-0 (Rename 08 - V2).
09	As per Opt 08.
10	Modify Design and Re-appraise in option 12 (new, amalgamated design option).
11	As per 10.
12 (New)	Amalgamated design option' targets desire lines from option 10. Also include an alternative junction arrangement described under Opt 03.

9.6.1.7 North Section

The North section contains a number of alignments which are coincidental. In summary, these alignments can for the purposes of brevity be grouped as follows:

(1) Options 01A and 01A/01B;

(2) Options 02A, 02A/02B, 07, 08 and 09

(3) Option 03;

(4) Option 04;

(5) Options 05 and 06;

(6) Option 10; and

(7) Option 11.

[72] Abbreviations in Table include:

POA: Preliminary Options Assessment;

SC: Score Card;

WD: Workshop Discussions.

The underlined option will be discussed for the purposes of this report. It should be noted that junction arrangements in Collinsford/Lugnagall have already been discussed in the 'Central Section'.

9.6.1.7.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 9-54. In general, options 07 and 09 are the best scoring options followed closely by options 08 and 11. In order to assist in the refinement process, Table 9-55 outlines the 'Very Low' and 'Low' preference ranks. It is apparent that the majority of these scores occur against options 05, 10 and 11.

Table 9-54: North Section: Full Scores Compilation

Disipine		Feasible Route Option – North Section												
		1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Eng	Traffic & Transport	0	0	0	0	0	0	0	0	0	0	0	0	0
	Road Engineering	1	1	2	2	2	2	1	1	1	2	1	1	2
	RSIA	0	0	0	0	0	0	0	0	0	0	0	0	0
Eco	Options Comparison Est.	3	3	1	1	3	3	5	5	1	1	1	4	1
Environmental	Socio Economic	2	2	2	2	2	2	2	2	2	2	2	2	2
	Non - Agri	4	4	3	3	2	2	4	4	3	3	3	4	1
	Noise & Vibration	3	3	3	3	3	3	3	3	3	3	3	2	2
	Air Quality	3	3	3	3	3	3	3	3	3	3	3	2	2
	Agriculture	3	3	3	3	3	3	5	5	3	3	3	4	3
	Flora	3	3	3	3	3	3	2	2	1	1	1	4	5
	Fauna	3	3	4	4	3	3	2	2	1	1	1	3	5
	Fisheries	2	2	3	3	3	3	3	3	3	3	3	3	3
	Flora, Fauna & Fisheries	3	3	3	3	3	3	2	2	2	2	2	3	4
	Hydro & Hydro Geol	4	4	4	4	4	4	4	4	4	4	4	5	5
	Soils & Geology	4	4	2	2	4	4	3	3	2	2	2	3	4
	Landscape	3	3	4	4	4	4	4	4	4	4	4	5	5
	Visual	2	2	3	3	3	3	2	2	3	3	3	1	1
	Landscape & Visual	3	3	4	4	4	4	3	3	4	4	4	3	3
	Archaeology & CH	5	5	5	5	4	4	4	4	4	4	4	1	4
	Architectural H	3	3	2	2	1	1	1	1	1	1	1	1	1
	Urban Planning	0	0	0	0	0	0	0	0	0	0	0	0	0
Overall Index, Rank and Preference	Overall	40	40	37	37	38	38	40	40	32	33	32	35	34
	STRAIGHT RANKING	10	10	6	6	8	8	10	10	1	3	1	5	4
	Preference	4	4	3	3	3	3	4	4	1	2	1	3	2

Table 9-55: North Section – 'Very Low' Preference and 'Low' Preference ranks

Discipline	Feasible Route Options												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Traffic	-	-	-	-	-	-	-	-	-	-	-	-	-
Road Engineering		-		-				-	-		-		-
RSIA	-	-	-	-	-	-	-	-	-	-	-	-	-
Options Estimate		-		-			X	-	-		-	X	-
Socio-Eco		-		-				-	-		-		-
Non-Agri	X	-		-			X	-	-		-	X	
Noise & Vibration		-		-				-	-		-		-
Air Quality		-		-				-	-		-		
Agriculture		-		-			X	-	-		-	X	
Ecology		-		-				-	-		-		X
Hydro & Hydro Geology	X	-	X	-	X	X	X	-	-	X	-	X	X
Soils & Geology	X	-		-	X	X		-	-		-		X
Landscape and Visual		-	X	-	X	X		-	-	X	-	X	X
Archaeology & Cultural Heritage	X	-	X	-	X	X	X	-	-	X	-		X
Architectural Heritage		-		-				-	-		-		
Urban Planning	-	-	-	-	-	-	-	-	-	-	-	-	-
Totals	4	-	3	-	4	4	5	-	-	3	-	5	5

9.6.1.7.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 9-56. In terms of Engineering and Environment, there is no distinguishable difference between the various route options. Arising from the Options Comparison Estimates, the Economics section shows options 05 and 10 to be more expensive options.

Table 9-56: North Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Feasible Route Option												
	1A	1A/B	2A	2A/B	3	4	5	6	7	8	9	10	11
Engineering Average Rank	1	1	2	2	2	2	1	1	1	2	1	1	2
Economics Average Rank	3	3	1	1	3	3	5	5	1	1	1	4	1
Environment Average Rank	3	3	3	3	3	3	3	3	3	3	3	3	3

9.6.1.7.3 *Workshop Discussions*

Similar to the Central Section, discussions in relation to the Northern Section were focussed predominately on Environmental impacts. The main impacts discussed were negative landscape impacts in a visually vulnerable area, impacts on property and people, impacts on ecological habitats particularly groundwater dependent ecosystems and impacts on upstanding archaeological features. The discussions focussed on the most desirable lines through this area which would insofar as possible, avoid, or reduce the impacts on the foregoing. Again, similar to the 'Central' section, the score cards did not in some instances reflect the significance of some impacts due again to their isolated nature.

It was generally agreed, that the design should as far as possible remain proximate to the existing N16. Noting the geometry at *Gortnagrelly* and considering the requirement for a full bend realignment, it was considered that the only viable option of those initial 'Feasible Route Options' would be one which would run to the north of the existing domestic properties and in so doing bridge across the identified ecological habitats (Tufa Mounds). However, it was recommended that a further alternative solution should consider the use of design relaxations/departures to provide an alignment closer to the existing N16.

Landscape impacts arising from the northern limits (north east of *Gortnagrelly*) of options 10 and 11 were considered too significant for further consideration.

9.6.1.7.4 *North Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the 'Preliminary Options Assessment' and the subsequent workshop.

Discount Options

The following outlines options which have been recommended to be discounted following the 'Preliminary Options Assessment'.

Option 01A

It was recommended that option 01A be discounted for the following reasons:

- Negative impacts arising, in relation to Non-Agricultural property aspects.

Option 02A

Although some aspects of option 02A were recommended to be discounted, it was considered that other aspects were desirable and should be progressed in amalgamated design option 12 (new) as described below.

Option 03

Option 3 was generally considered a desirable option, however in consideration of the fact that the amalgamated design option 12 as described below has similar characteristics to this option, it was considered that there was no merit in retaining it for the 'Stage 1, Part 2' assessment. In this regard and purely for ease of assessment, option 3, in a label sense only is discounted from the process.

Option 04

Option 04 was generally considered a desirable option, however in consideration of the fact that the amalgamated design option 12 as described below has similar characteristics to this option, it was considered that there was no merit in retaining it for the 'Stage 1, Part 2' assessment. In this regard and purely for ease of assessment, option 4, in a label sense only is discounted from the process.

Option 05

Option 05 was recommended to be discounted due to negative property impacts and due to the fact that ecological impacts associated with same in the townland of *Gortnagrelly* were similar to other route options.

Option 10

Due to negative landscape and property impacts, the north eastern section of option 10 was recommended to be discounted, however, it was considered that other aspects were desirable and should be progressed in amalgamated design option 12 which is described below.

Option 11

Due to negative landscape and ecological impacts, the northern section of option 11 was recommended to be discounted, however, it was considered that other aspects were desirable (similar to option 10) and should be progressed in amalgamated design option 12 which is described below.

Design Modifications

Option 08

Arising from the Stage 1, Part 1, 'Preliminary Options Assessment', it was recommended that option 08 should progress to the next stage of the assessment. The new arrangement shall bridge across the L-3404-0.

Option 12 – Amalgamated Option

An amalgamated design option has been developed in the 'North Section' arising from the 'Preliminary Options Assessment' and the subsequent discussions at the Multi Disciplinary Workshop. This option utilises aspects of options 03 (north portion of the 'North Section'), 4 (north portion of the 'North Section'), 10 (south portion of the 'North Section') and 11 (south portion of the 'North Section')

Option 12 (v2) – Amalgamated Option

Further to discussions at the Multi Disciplinary Workshop, an alternative version to option 12 has been developed for a localised area in *Gortnagrelly*. This option considers design relaxations aligning the proposed route more closely with the existing N16.

Summary

In general, the foregoing sets out, the status of the various routes following the 'Preliminary Options Assessment'. Figure 9-15 and Table 9-58 provides a summary of this status.

Figure 9-15: North Section - Recommendations arising from Preliminary Options Assessment and from Multi Disciplinary Workshop [73]

Feasible Route Option	Recommendation
01A	Discount based on POA, SC and WD.
01A/01B	As per 01A
02A	Modify Design and Re-appraise in Option 12 (new – amalgamated design option)
02A/02B	As per 02A
03	Modify Design and Re-appraise in Option 12 (new – amalgamated design option)
04	As per 03
05	Discount based on POA, SC and WD.
06	As per 05
07	As per 08
08	Modify Design and Re-appraise.
09	As per 08
10	Modify Design and Re-appraise in Option 12 (new – amalgamated design option)
11	As per 10
12 (New)	Amalgamated Design Option targets desire lines from FRO 02A, 03 08 & 10. Also include an alternative junction arrangement described under Opt 03. Alternative separate Opt 12-v2 also considered in Gortnagrelly.

9.6.2 Refined number of Route Options to proceed to Stage 1, Part 2, Preliminary Options Assessment.

The Refined number of route options to proceed to Stage 1, Part 2, Preliminary Options Assessment of the Route Selection Process have been set out sections 9.6.1.5.4, 9.6.1.6.4 and 9.6.1.7.4. Table 9-57 provides a summary status in terms of 'Sectional Splits'.

[73] Abbreviations in Table include:

POA: Preliminary Options Assessment;

SC: Score Card;

WD: Workshop Discussions.

9.7 Public Consultation No. 03: Refined 'Feasible Route Options'

A third Public Consultation for the Route Selection Process commenced on the 27th of July, 2016, with 2 open days/evenings in the Clarion Hotel, Sligo. The consultation period, extended to the 8th of September.

Although questionnaires did not form part of this particular consultation, additional submissions were encouraged. 16 submissions were received, each of which were subsequently considered in the proceeding Stage 1, Part 2, Preliminary Options Assessment.

Table 9-57: Sections Summary Status[74]

Section	Opt 1A	Opt 1A/B	Opt 1A (v2)	Opt 1A/B (v2)	Opt 2A	Opt 2A/B	Opt 2A (v2)	Opt 2A/B (v2)	Opt 3	Opt 4	Opt 5	Opt 6	Opt 7	Opt 8	Opt 8 – v2	Opt 9	Opt 10	Opt 11	Opt 12	Opt 12 v2	Opt 13
South	×	×	✓	✓	×	×	✓	✓	×	×	✓	×	×	×	×	×	×	×	✓	n/a	✓
Central	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓	×	×	×	✓	n/a	n/a
North	×	×	×	×	×	×	×	×	×	×	×	×	×	×	✓	×	×	×	✓	✓	n/a

Table 9-58: N16 Preliminary Options Assessment – Routes Status

OPTION	SOUTH	CENTRAL	NORTH
Option 1A	Design modified to pass over the L-7421-0 (Ballytivnan Road/Old Bundoran Road) in Carncash.	Discount Design – South section modified to tie in with option 8 (Central)	Discount
Option 1A/1B	As per 01A	As per 1A	Discount
Option 2A	Design modified to pass over the L-7421-0 (Ballytivnan Road/Old Bundoran Road) in Carncash. Will require alternative junction arrangements which may impact on Socio – Economic aspects.	Discount Design – South section modified to tie in with option 5 (Central)	'Amalgamated Design Option' described below corresponds generally to Opt 2A.
Option 2A/2B	As per 2A	As per 2A	As per 2A
Option 03	Discount Mainline Alignment Consider East/West link going forward as a possible extension to other design options. See option 13.	Discount – But include Junction arrangement as an alternative solution in Collinsford/Lugnagall.	'Amalgamated Design Option' described below corresponds generally to Opt 3.

[74] Notes:

× Discounted

✓Proceed to next stage of assessment

OPTION	SOUTH	CENTRAL	NORTH
Option 04	Discount	As per 3	'Amalgamated Design Option' described below corresponds generally to Opt 4.
Option 05	Maintain Design – Proceed to next stage of Assessment	Maintain Design	Discount Design – Central section lends itself to tying in with the modified option 8, or with the 'Amalgamated Design Option' described below.
Option 06	Discount	As per 5	As per 5
Option 07	Discount	As per 8	As per 8
Option 08	Design modified (and included in option 12 – 'Amalgamated Design Option') to avoid a direct impact on a protected structure (ACH 06)	Design modified to pass over the L-3404-0 in Lugnagall with alternative junction arrangements;	Maintain Design (as a result of new junction arrangements in the 'Central').
Option 09	Discount	As per 8	As per 8
Option 10	Discount	'Amalgamated Design Option' described below utilises some aspects (north in Central) of Opt 10. Reappraise the junction arrangement of option 10 against other junction arrangements at this location – May not be possible to appropriately fully consider until 'Design Stage'	The most northerly section is discounted. The southern part of this section corresponds generally to the 'Amalgamated Design Option'
Option 11	Discount	As per 10	As per 10
Option 12 (Amalgamated Design Option)	Option 7, 8 & 9: Option 8 is amalgamated with option 7 on the approach to the AbbVie Roundabout; Option 8 is modified at the crossing point with the L-3407-22 to reduce impacts on a protected structure;	'Amalgamated Design Option' closely follows original design Option 10;	'Amalgamated Design Option' uses elements of Options 2A, 2A/B, 3 and 10
		Variation to Opt 12: Addenda alternative junction arrangement provided in Collinsford/Lugnagall; May require progression to 'Design – Phase 3' in order to resolve junction arrangement;	Variation to Opt 12: Alternative alignment at Gortnagrelly; May require progression to 'Design – Phase 3' in order to resolve optimal alignment;
Option 13 (East/West Element of FRO 03, 04, 10 & 11)	East/West link which was subsequently part of Option 3 is retained as a possible extension to other Route Options (i.e. Option 5 and 8);	N/A	N/A

10 Stage 1 – Part 2: Preliminary Options Assessment (Refined Feasible Route Options)

10.1 Description of Refined Feasible Route Options

The methodology for the Refinement of Route Options (1st Iteration) has been set out in the preceding section of this Route Selection Report.

The following paragraphs provide a brief overview of the Refined 'Feasible Route Options' (1st Iteration), relative to the previously outlined Feasible Route Options.

The assessment has been carried out in a similar manner to that already described for Part 1 of the Preliminary Options Assessment. The following, provides a general background to the Stage 1 – Part 2 assessment which is expanded upon in each individual report contained within the respective Volumes 2, 3 and 4 of the Route Selection Report. In addition, Volume 5 should be referred for Figurative details. The following Strategic Options proceeded to the Stage 1, Part 2 Preliminary Options Assessment.

Table 10-1: Strategic Description of Routes

Strategic Option	Strategic Nature
1	Connecting the N16 to the N15, at *Teesan* townland
2	Connecting N16 to N15 at *Shannon Eighter* townland
4	Maintains the current strategic nature, i.e. tying into the AbbVie Roundabout.

There are similarities in certain cases between some of the FRO's. The following sections, give a very brief overview of each particular Refined 'Feasible Route Option'.

10.1.1 Refined 'Feasible Route Option' 01A – v2

Feasible Route Option 01A has been modified to become Refined 'Feasible Route Option' 01A – v2. The south section is retained; however, the at-grade junction previously proposed at this options intersection with the L-7421-0, has been replaced with an underbridge arrangement which separates the national and local network. The Central and North sections of Option 01A, did not progress past the Stage 1, Part 1,'Preliminary Options Assessment', therefore the southern section of this option, now ties in with Refined 'Feasible Route Option' 08-v2 (see section 10.1.7) in the townland of *Lugatober*.

10.1.2 Refined 'Feasible Route Option' 01A/B – v2

Feasible Route Option 01A/B has been modified to become Refined 'Feasible Route Option' 01A/B – v2. The south section is retained; however, the at-grade junction previously proposed at this options intersection with the L-7421-0, has been replaced with an underbridge arrangement which separates the national and local network. The Central and North sections of Option 01A, did not progress past the Stage 1, Part 1, 'Preliminary Options Assessment', therefore the southern section of this option, now ties in with Refined 'Feasible Route Option' 08-v2 (see section 10.1.7) in the townland of *Lugatober*.

10.1.3 Refined 'Feasible Route Option' 02A – v2

Feasible Route Option 02A has been modified to become Refined 'Feasible Route Option' 02A – v2. The south section is retained; however, the at-grade junction previously proposed at this options intersection with the L-7421-0, has been replaced with an underbridge arrangement which separates the national and local network. The Central and North sections of Option 02A, did not progress past the Stage 1, Part 1, 'Preliminary Options Assessment', therefore the southern section of this option, now ties in with Refined 'Feasible Route Option' 05 (see section 10.1.5) in the townland of *Lugatober*.

10.1.4 Refined 'Feasible Route Option' 02A/B – v2

Feasible Route Option 02A/B has been modified to become Refined 'Feasible Route Option' 02A/B – v2. The south section is retained; however, the at-grade junction previously proposed at this options intersection with the L-7421-0, has been replaced with an underbridge arrangement which separates the national and local network. The Central and North sections of Option 02A/B, did not progress past the Stage 1, Part 1, 'Preliminary Options Assessment', therefore the southern section of this option, now ties in with Refined 'Feasible Route Option' 05 (see section 10.1.5) in the townland of *Lugatober*.

10.1.5 Refined 'Feasible Route Option' 05

Feasible Route Option 05 has been modified and retained in the south and central section's to become Refined 'Feasible Route Option' 05. The north section of Option 05 did not progress past the Stage 1, Part 1, 'Preliminary Options Assessment', therefore the central section of this option, now ties in with Refined 'Feasible Route Option' 08 – v2 (see section 10.1.6) in the townland of *Collinsford*.

10.1.6 Refined 'Feasible Route Option' 08 – v2

Feasible Route Option 08 has been modified and retained in the Central and North section's to become Refined 'Feasible Route Option' 08 – v2. The junction arrangement previously proposed in the townland of *Collinsford/Lugnagall* has been modified with the consideration of an underbridge arrangement.

The south section of Option 08 did not progress past the Stage 1, Part 1, 'Preliminary Options Assessment', therefore the central section of this option, now ties in to the south with Refined 'Feasible Route Option' 12 (see section 10.1.7) in the townland of *Drumkilsellagh*.

10.1.7 Refined 'Feasible Route Option' 12

Refined 'Feasible Route Option' 12 is a design not previously proposed in the Feasible Route Options and includes amalgamated sections of certain Feasible Route Options.

The following outlines how this design relates to the initial Feasible Route Options.

10.1.7.1 South Section

In the south section, Refined 'Feasible Route Option' 12 is an amalgamation; of Feasible Route Option 07 leaving the AbbVie roundabout and connecting with Feasible Route Option 08 in the townland of *Faughts* where there is a minor alignment change from Feasible Route Option 08.

10.1.7.2 Central Section

In the Central Section, the Refined 'Feasible Route Option' closely follows the design of Feasible Route Option 10.

10.1.7.3 North Section

In the North Section, the Refined 'Feasible Route Option' closely follows the design of Feasible Route Options 02A, 03 and 10.

10.1.8 Refined 'Feasible Route Option' 12 – v2

Refined 'Feasible Route Option's 12 – v2 is a modified version of Option 12 in the townland of *Gortnagrelly*.

10.1.9 Refined 'Feasible Route Option' 13

Refined 'Feasible Route Option' 13, is a possible addenda element to Options 05 and 12, to the south. This option provides the potential for an east/west connection between the N16 and N15.

10.2Assessment Methodology

10.2.1 Framework Matrix

The Assessment Methodology for the Stage 1, Part 2 assessment is similar to that already outlined in section 9.2.1 for the Part 1 assessment; that is with the exception of a numerical change in the correlation between 'Relative Ranks' and 'Preference Ranks' with the Framework Matrix. This is as outlined in Table 10-2 and is reflective of the reduction in the number of route options now being assessed.

Table 10-2: Application of Ranks to 'Preferences'

Relative Rank		Preference	Preference Rank
From	To		
1		Very High Preference	1
2		High Preference	2
3	4	Medium Preference	3
5		Low Preference	4
6		Very Low Preference	5

The following outlines the results of the Preliminary Options Assessment, Part 2.

10.3Engineering Assessment

10.3.1 Traffic and Transport Assessment

10.3.1.1 Outline

Three route selection assessment Technical Notes were undertaken as part of this N16 Route Selection Study as already referred to in section 8.1 of this Report. This phase of the Traffic & Transport Assessment relates to the report below, which should be referred to (Volume 2, Part A, Section 3 of the Route Selection Report) for a fuller appreciation of the assessment.

- N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016);

10.3.1.2 Assessment

The KPI Testing Technical Note issued in December 2016 detailed the traffic assessment for the route selection focussing on the strategic and specific study objectives for the N16 scheme. The aim

of this KPI assessment was to provide input to support the sifting of the range of options for the proposed N16 scheme. This study was undertaken for seven options in addition to the Do Nothing and Do Minimum. The strategic and specific objectives of the N16 route selection study and the KPIs developed to quantify how well each option achieved the objective are detailed in Table 10-3 and Table 10-4 below.

Table 10-3: Strategic Objectives and KPI's

Item	Objective	KPI
1	Meet the policy objectives of National/Regional/County/Local policy documents including both TII and SCC	Qualitative
2	Meet the specific objectives of National/Regional/County/Local policy documents including both TII and SCC	Qualitative
3	Effectively cater for strategic traffic	A: AADTs on N16 B: Select Link Analysis of traffic on N16 at Leitrim Boundary
4	Effectively cater for strategic traffic	AADTs on N15 and N4
5	Efficiently cater for strategic National Road traffic	Journey times from N16 at Leitrim Boundary to N4/N16/N15 junction
6	Efficiently cater for strategic traffic to Sligo City Gateway (NSS)	Journey times from N16 at Leitrim Boundary to Sligo City Centre
7	Operational efficiency of N16	A: V/C ratio of junctions on N16 B: Turn delays at junctions on N16

Table 10-4: Specific Objectives and KPI's

Item	Objective	KPI
8	Ensure local roads cater for local movement	AADTs on local and regional roads within study area to north of Sligo City appropriate to local levels.
9	Road network to cater for future traffic	A: Number of V/C ratios broken into bands throughout Sligo modelled network. E.g.: number of junctions >85%, 50%-85%, <50%. B: GIS map indicating these locations
10	Reduce congestion on network	Transient and overcapacity queuing
11	Overall network operations	A: Overall travel distance B: Overall travel time C: Average network speed
12	Environment	Vehicle emissions
13	Operational efficiency of N15	V/C ratio of junctions on N15
14	Operational efficiency of key City Centre junctions	V/C ratio of key junctions within Sligo City Centre
15	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City Centre

10.3.1.2.1 *Strategic Objectives and KPI's*

Objective 01

Objective 1 was to meet the high level objectives of National, Regional, County and Local policy documents. The context of these policy documents has already been set out in Section 3.2 of this Main Report. In summary, it was determined that each Feasible Route Option would be consistent with high level objectives described in National, Regional, County and Local policy documents.

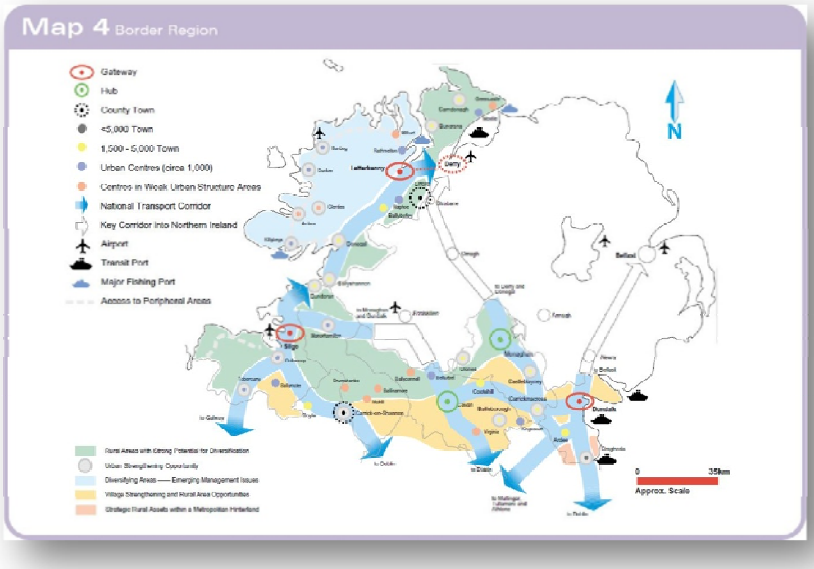
Objective 02

Objective 2 was to meet the specific objectives of National, Regional, County and Local policy documents.

National Policy Documents

The National Spatial Strategy has identified Sligo as one of three broad areas to be considered in a more detailed manner within the national structure. Sligo is one of three gateways in the border region as illustrated in Figure 10-1 below. These gateways are to drive development through enhanced critical mass, accessibility and capacity for development. This in turn will assist the need of other towns, villages and rural areas to develop roles complementary to those of the gateways to ensure that a wider area will benefit from the critical mass in the region provided by the gateways.

Figure 10-1: Border Region (Map 4 of the National Spatial Strategy)



An enhanced N16 would strengthen the development in the border region by providing an improved road link with counties Leitrim and Cavan as well as on one of the key corridors to Northern Ireland.

Regional Policy Documents

The Regional Planning Guidelines for the Border Region states that its vision is:

'By 2022, the Border Region will be a competitive area recognised as, and prospering from, its unique interface between two economies, where economic success will benefit all, through the implementation of the balanced development model, which will provide an outstanding natural environment, innovative people, which in themselves, will be our most valuable asset'.

It has set out key strategic goals to achieve this vision, which include;

- To improve intra and inter regional connectivity and mobility throughout the Region through the development of Strategic Radial Corridors and Strategic Links;
- To co-ordinate and integrate key issues in National and Regional Spatial Planning Strategies and in particular, the National Spatial Strategy and the National Development Plan, and associated inter-regional development initiatives that support and promote strategic links;
- To co-ordinate and integrate key aspects of cross border spatial planning strategies, and in particular, the Regional Development Strategy for Northern Ireland and associated inter-

regional development initiatives, that support and promote strategic links between the two economies;

- To exploit the Regions unique location at the interface between two economies, by putting in place the drivers for economic growth, through the development of the Eastern Corridor, Atlantic Arc and the Central Border Area.

County and Local Policy Documents

Sligo County Development Plan 2011 - 2017

As already outlined in section 3.2.8 of this Route Selection Report, it is an objective of the County Development Plan to facilitate programmed improvements to the National Road network including the realignment of the N16 Sligo City to Leitrim County boundary.

Sligo and Environs Development Plan 2010 – 2016

The Sligo and Environs Development Plan (SEDP) has a number of strategic goals including the build-up of linkages between Sligo and the other Gateways and Hubs within the Border Region and adjoining regions, such as the Western Region and Northern Ireland, by supporting the implementation of the RPGs, collaborating on support for critical enabling of infrastructure such as road and rail connections, and cooperating in areas of mutual planning interest.

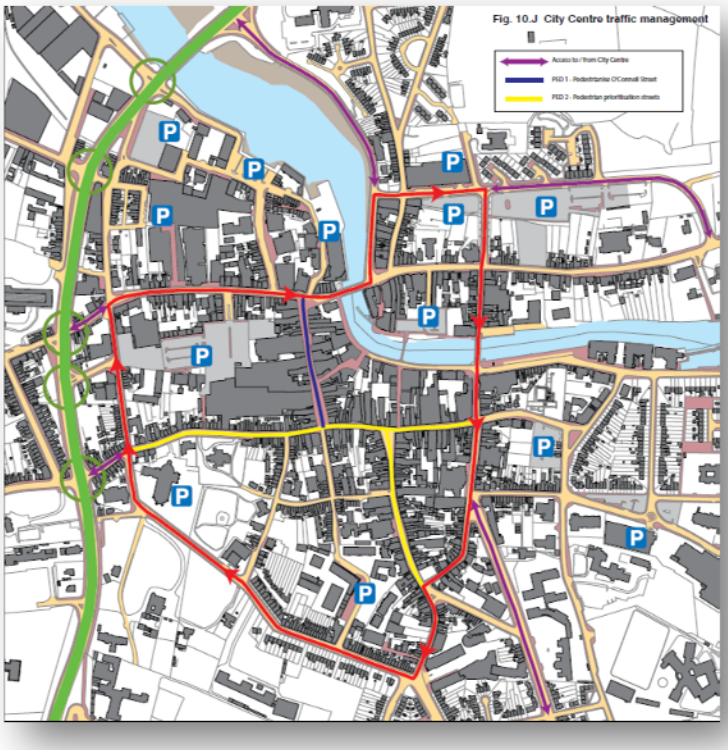
The SEDP also details a number of broad aims including the supporting of balanced economic development and improved mobility in the city centre. This is to be achieved by;

- Facilitating and encouraging the sustainable development of the Gateway City of Sligo as an economic growth driver for the North-West, in accordance with the NSS;
- Integrating business locations with the surrounding land use and transportation network;
- Working with the providers of infrastructure to ensure adequate provision in terms of road, rail, aviation, energy and telecommunications;
- Policies for city centre traffic management and pedestrian priority objectives for a pedestrian friendly city centre.

In terms of city centre traffic management, Figure 10-2 below from the SEDP illustrates that the R286 Connaughton Road, R870 Markievicz Road, Lord Edward Street, Upper John Street and the R870 Pearse Road should facilitate vehicular access to and from the city centre.

Figure 10-2 also presents proposals to introduce pedestrian friendly measures south of the River Garvogue in the areas of O'Connell Street, John Street, Grattan Street, Market Street and High Street.

Figure 10-2: City Centre Traffic Management and Pedestrian Prioritisation



Objective 15 set out below, assesses the impact of each option on the future pedestrianisation of Sligo city centre through traffic volume changes on links within Sligo city centre. Retaining vehicles on the main access routes in purple and away from areas of higher pedestrian numbers in blue and yellow has been considered.

Objective 03

Objective 3 was to effectively cater for strategic traffic. Two KPIs were assessed as part of this objective. The first was the AADT on the N16, N15 and N4. The second was the Select Link Analysis of AM peak inbound traffic on the N16 at the Leitrim boundary. The results of these KPIs are detailed below.

AADT on the N16

The AADT at various critical locations on the N16 alignment are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

It can be seen that in the Do Minimum traffic volumes increase on the approach to Sligo, but reduces slightly to the south of the N16 junction with the L-3407-22 due to traffic using the L-7422-0 as an alternative route to the N16.

Options 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 show similar patterns of traffic using the N16, with greater reductions in traffic on the N16 as it gets closer to the N15. This highlights that traffic demand on the N16 is focussed more within Sligo and results in this demand utilising the existing N16 route as an alternative to the proposed alignments.

Options 05 and 08 showed similar traffic patterns with traffic volumes on the proposed N16 alignments increasing closer to Sligo. This suggests that these routes generally cater for the demand to Sligo, with limited use of the alternative routes to the N16. Option 05 caters for the highest demand levels of all of the alignment options, followed by Option 08.

Select Link Analysis

A Select Link Analysis (SLA) was undertaken for each model variant to present the routing pattern for traffic using the N16 in the inbound direction for the AM peak. The routing along the N16 for each option is presented within the aforementioned Volume 2, Part A, and as Figure N16-RS-098 within Volume 5 of the Route Selection Report.

It is apparent, as already outlined, that the introduction of the Eastern Garvogue Bridge (EGB) in the Do Minimum scenario causes changes to the routing of traffic using the N16 inbound. The EGB provides an alternative crossing of the Garvogue River to the current crossings in the city centre. This reduces traffic using the city centre part of the network, making the routes to and from the current crossings more desirable than in the existing situation. This results in traffic routing from the N16 onto the L-7422-0 to enter Sligo via the Ballytivnan Road, in the Do Minimum scenario.

In the revised Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 scenarios the proposed N16 is bridged over the L-7421-0 and L-7422-0 preventing access to Sligo via the Ballytivnan Road. This ensures traffic remains on the proposed N16 and continues to the N15 to access Sligo City Centre in these four scenarios. However, the Select Link Analysis has indicted that there is a relatively low traffic flow using the western section of the proposed N16 in Option 01A-v2, 01A/01B0v2, 02A-v2 and 02A/02B-v2 as up to 50% of vehicles find the existing N16 route more desirable in these four options. Option 05 and 08 perform better in terms of retaining the demand along their N16 option alignments.

Objective 4

Objective 4 was to effectively cater for strategic traffic. The KPIs assessed as part of this objective were the AADTs on the N15 and N4. The results of these KPIs are detailed below.

AADT on the N15

The AADT locations and values on the section of N15 adjacent to the N16 alignment are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). The section of the N15 in question, spans just north of where the proposed N16 intercepts in Option 01-v2 to the signalised junction of the R291 Rosses Point road.

It can be seen that on the N15 north of where the proposed N16 intercepts it, the northbound and southbound flows are relatively constant across all the scenarios.

The northbound and southbound flows on the N15 immediately south of where the proposed Option 01A-v2 intercepts it, have been included indicating that the southbound flow is approximately 700 vehicles greater than the northbound in Options 01A-v2 and 01A/01B-v2.

Further south, to the N15's junction with Scotsman's Walk (L-90102-0), AADT levels are over one thousand vehicles less in Options 02A-v2 and 02A/02B-v2 when compared with Options 01A-v2 and 01A/01B-v2 owing to the Option 02-v2 proposed N16 intercepting the N15 further south than option 01-v2. AADT's between Scotsman's Walk and the junction with the Rosses Point Road (R291) then restore to more equal levels between Options 01 and 02. However, it has been noted that the flows just north of the N15's junction with the Rosses Point road are lower in the 01A/01B-v2 and 02A/02B-v2 options than the 01A-v2 and 02A-v2 options, as vehicles utilise Elm Gardens to and from Sligo city centre rather than using the N15/N16 junction. The traffic model indicates that the proposed roundabout junctions on the N15 in Options 01A/01B-v2 and 02A/02B-v2 are causing delay and vehicles are diverting to avoid this.

Option 05 and 08 show very similar N15 AADT flows with the Do Minimum scenario.

AADT on the N4

The AADT values at locations on the N4 are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

The locations of the AADTs are on the section of the N4 spanning above the signalised junction of Upper John Street to the south, and just below where the existing N16 intercepts to the north.

The flows at the southernmost section of the N4 analysed indicate a marked increase across Options 01-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 when compared with the Do Minimum scenario, with no significant changes experienced on Options 05 and 08.

The flows at the northernmost section of the N4 analysed indicate a decrease in northbound flows in Option 01A/01B-v2 and 02A/02B-v2, with the remaining options having relatively unchanged northbound flows. Southbound flows are fairly constant across all options.

Wider Sligo Network AADT

A wider assessment of the road network within the study area is presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

Objective 5

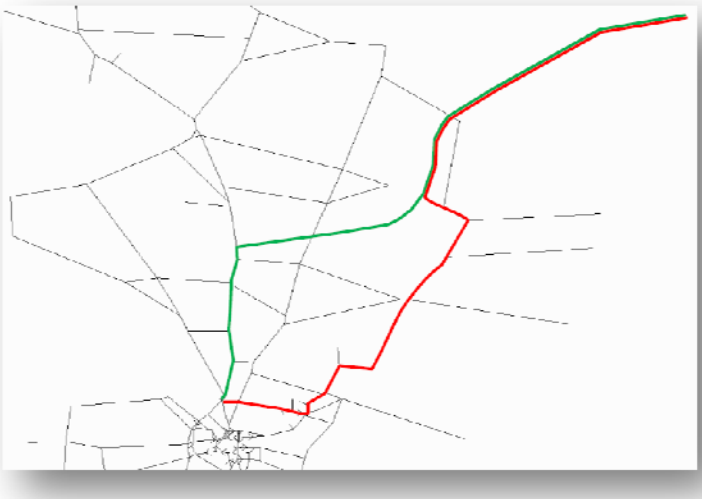
Objective 5 was to efficiently cater for strategic national road traffic. This KPI was assessed using journey times from the N16 at the Leitrim boundary to the N4 / N16 / N15 junction[75].

The AM, IP and PM peak journey time comparisons for the route options between the Leitrim county boundary and the N4 / N16 / N15 junction across 2017, 2032 and 2047 are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). The results show a marked reduction in journey time for the Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 compared to the Do Nothing and Do Minimum scenarios across all time periods. Option 02A-v2 and 02A/02B-v2 offer the quickest journey times across all options. However, it is important to stress that there is a much lower level of traffic using these routes as demonstrated by the Select Link Analysis already described in this section.

For illustration purposes the option 01A/01B-v2 routes using the proposed N16 (green) and existing N16 (red) are shown in Figure 10-3 below.

[75] This is an arbitrary destination point as opposed to one which reflects traffic destination attractiveness.

Figure 10-3: Journey Time routes illustration (Opt 01A-v2) for the proposed N16 (green) and the existing N16 (red)



Across all options, the Design year 2032 and Forecast year 2047 journey times are only marginally different owing to expected tapering of demand from 2032 onwards and thus minimal growth in demand for travel.

Objective 6

Objective 6 was to efficiently cater for strategic traffic to Sligo City Gateway (NSS). This KPI was assessed using journey times from the N16 at the Leitrim boundary to Sligo city centre.

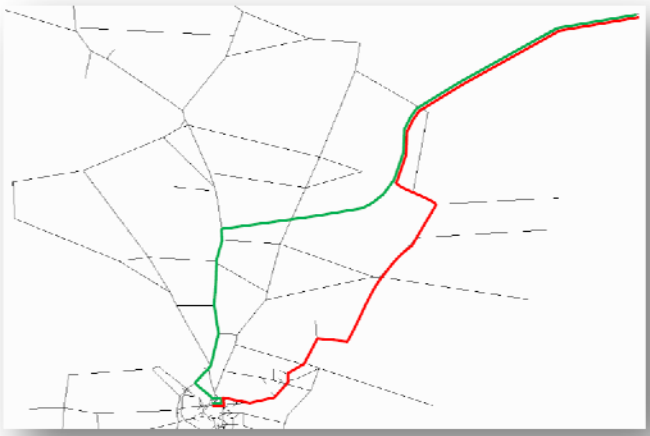
The AM, IP and PM peak journey time comparisons for the route options between the Leitrim county boundary and Sligo city centre across 2017, 2032 and 2047 are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

The results show a reduction in journey times in all options when compared to the Do Nothing and Do Minimum scenarios across all time periods. For information purposes, Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 include two journey times for each option. These journey times are when using the proposed N16 and using the existing N16. The models indicate that in most cases in these four options the proposed N16 route to the city centre is slightly quicker than the existing N16 route (However, it is again important to note that this does not factor in the results of the previously quoted Select Link Analysis).

For consistency the same city centre junction has been used as the end point of the journey time route for all options. This location is the priority junction (SATURN node 510) on the east side of the R292 Hyde Bridge where it meets with the R286 Stephen Street. The Do Nothing, Do Minimum, Option 05 and 08 each access the city centre via Molloway Hill, Connaughton Road, Lake Isle Road and Stephen Street. Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 each access the city via the proposed N16, N15, N4, Markievicz Road, Connaughton Road, Lake Isle Road and Stephen Street. For each of these four options a second journey time was recorded using the existing N16, Molloway Hill, Connaughton Road, Lake Isle Road and Stephen Street to access the city centre.

For illustration purposes the option 01A/01B-v2 routes using the proposed N16 (green) and existing N16 (red) are shown in Table 10-4 below.

Figure 10-4: Journey Time routes illustration (Opt 1A_S1A) for the proposed N16 (green) and the existing N16 (red)



Across all options, the Design year 2032 and Forecast year 2047 journey times are only marginally different owing to expected tapering of demand from 2032 onwards and thus minimal growth in demand for travel. The quickest routes to the aforementioned City Centre destination point are the green route of option2A-v2 and option 05.

Objective 7

Objective 7 was to assess the operational efficiency of the N16. Two KPIs were assessed as part of this objective. The first was the Volume/Capacity ratios on the N16. The second was the right turn delay at junctions on the N16. The results of these KPIs are detailed below.

Volume / Capacity ratios on the N16

The Volume / Capacity ratios of junctions on the N16 are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). These ratios detail the AM, IP and PM peak periods for the years 2017, 2032 and 2047.

For each scenario the Volume/Capacity ratios along the whole of the N16 begin at the Leitrim County Boundary (SATURN Node 614) and continue to the N4/N16/N15 junction (SATURN Node 2).

Across all scenarios most of the Volume/Capacity ratios of junctions on the N16 were under 50% with a small number of junctions between 50% - 85%. No junctions on the N16 had a Volume/Capacity ratio of over 85%.

It is also worth noting that Option 01A/01B-v2 had four consecutive junctions with an amber Volume/Capacity ratio (50%-85%). SATURN Node 1101 (the roundabout junction with the Proposed N16 and N15), Node 18 (N15), Node 19 (N15) and Node 148 (N15) each recorded a Volume/Capacity ratio of between 52.8% and 67.0% in the 2047 PM peak model. Although these ratios are well within 100% it has been identified as the worst performing section of any model scenario with these four consecutive junctions experiencing congestion, albeit at no more than two thirds of the capacity available.

Turn Delay at Junctions on the N16

The Turn Delay at junctions on the N16 are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

The assessment details the AM, IP and PM peak periods for the years 2017, 2032 and 2047. For each scenario the Turn Delay at junctions along the whole of the N16 begins at SATURN Node 614 (at

Leitrim County boundary) and continues to Node 2 (at the N4 / N16 / N15 junction). Each model option has a varying number of nodes used which is reflected in the tables.

The turn delay experienced on the N16 in most scenarios is less than ten seconds with this figure rising slightly at junctions closer to Sligo city centre. The only delays experienced greater than 30 seconds were in a future Do Nothing scenario at the N4/N15 /N16 junction (SUTURN Nodes 501 & 2).

Discounting the Do Nothing scenario the greatest turn delay was again recorded at SATURN Node 2 (N4/N15 /N16 junction) where a delay of 23 seconds was experienced in the 2047 PM peak model in the Do Minimum, Option 01A-v2, Option 02A-v2, Option 05 and Option 08 scenarios.

Strategic Objectives and KPIs Summary

To summarise the strategic objectives and identify the higher scoring options a summary table has been created. Table 10-5 (see section 10.3.1.2.3), indicates that Options 05 and 08 (including option 12) perform the best at complying with the strategic objectives. Each of the options generally performs well against the objectives but in the circumstances in which it was deemed that an option did not score so well against an objective these are outlined below.

The proposed N16 AADT close to the junction with the N15 in Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 is quite low particularly in the northbound direction. This indicates that the proposed N16 is not well utilised in these options and that vehicles are using alternative routes.

The Select Link Analysis preformed on the existing N16 in the Do Minimum has shown that around 30% of southbound traffic diverts on to the Ballytivnan Road. In Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 the southbound traffic also splits itself (almost evenly in some scenarios) between the proposed N16 and existing N16 and so hasn't fulfilled this KPI.

The N15 experiences a reduction in AADT in Option 01A/01B-v2 and 02A/02B-v2 owing to the delay created with the roundabout proposals as part of the dual carriageway N15 upgrade in these two options. The delay experienced on this section of the N15 appears to be causing some vehicles to avoid the area by using Elm Gardens and Ballytivnan Road when travelling to and from Sligo city centre.

Journey times for route one to the N4/N16/N15 junction (Objective 05) were between 9-11 minutes for the Do Nothing and Do Minimum. The remaining options all performed better with journey times of between 7-11 minutes. Although Option 05 and 08 have been scored below the other options in Objective 5 it is important to stress that the Select Link Analysis has indicated that there is a low level of strategic traffic on the N16 travelling to the N4/N16/N15 junction. Journey times for route two to Sligo city centre (Objective 6) were between 10-12 minutes for the Do Nothing and Do Minimum. Each of the options recorded comparable reduced journey times, but it was Option 05 which recorded the quickest journey times to the city centre. Options 02A-v2, 02A/02B-v2 and 08 were the next quickest, followed by Options 01A-v2 and 01A/01B-v2.

Option 01A/01B-v2 has four consecutive junctions which have a Volume / Capacity ratio of between 52.8% and 67.0%. Although strictly speaking these junctions are on the N15 they are still part of the N16 route vehicles take to get to the N4/N16/N15 junction which was assessed consistently across all options.

A turn delay of over one minute was recorded in the Do Nothing 2047 PM peak at the junction of the existing N16 and N15. None of the other options recorded a turn delay greater than 23 seconds.

10.3.1.2.2 *Specific Objectives and KPIs*

Introduction

This section details the Specific Objectives and the results of the KPIs as described in Table 10-4. The comparison of KPIs achieved in this route selection study will quantify how well each option achieves the objective.

Objective 8

Objective 8 was to ensure local roads cater for local movement. The KPI assessed as part of this objective was the AADTs on local and regional roads within the study area to the north of Sligo city to assess if they were appropriate to local levels. The results of these KPIs are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

The most notable aspects from the aforementioned Objective 8 assessment include the following:

- The R291 Rosses Point Road AADT levels remain fairly constant across all scenarios;
- The Old Bundoran Road AADT levels are generally lower than the Do Nothing apart from the Do Minimum southbound which increased by 34% in 2017. However, this increase is to a lesser extent in the 2032 (17%) and 2047 (10%) models;
- When compared with the Do Nothing, the N16 north of Doonally Cross experienced a small reduction in northbound AADT in Options 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2. The southbound AADT on the N16 north of Doonally Cross had a greater reduction in AADT in Options 01A-v2, 01A/01B-v2, 02A-v2A and 02A/02B-v2.

Objective 9

Objective 9 was to determine if the road network could cater for future traffic. The KPI assessed as part of this objective was the Volume/Capacity ratios throughout the entire Sligo modelled network. The result of this KPI has been broken into three bands (number of junctions with V/C >85%, 50% - 85% and <50%) and is presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). The three bands have been colour coded red, amber and green. The results indicated that a high number of the junctions recorded a V/C ratio of less than 50% and in most cases the remaining junctions were between 50% - 85% inclusive. In one instance a V/C ratio of over 85% was recorded however this was in the 2047 AM Do Nothing scenario. The SATURN Node in question was the city centre signalised junction of the R292/O'Connell Street/Fish Quay.

In the AM and IP peak periods the number of V/C ratios between 50% - 85% is fairly constant with 4-6 and 1-2 junctions respectively. In the PM peak period the number is 6-11 with Option 02A-v2, 05 and 08 performing the best, each with six junctions between 50% - 85%.

Objective 10

Objective 10 was to reduce congestion on the network. The KPIs assessed as part of this objective were transient and over-capacity queuing. Transient queuing relates to the overall level of queuing throughout the entire model network that occurs associated with typical under-capacity junction operation, but ultimately can be accommodated by the network. Over-capacity queuing relates to the level of queuing associated with junctions that have reached capacity.

The results of these KPIs are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). The transient queuing recorded is fairly constant in each of the three peak periods (AM 217.6 – 225.2), (IP 151.9 – 171.2) and (PM 243.7 – 309.6). Option 02A/02B-v2 has the least amount of transient queuing in all peak time periods.

Over-capacity queuing outside of the Do Nothing scenario is minimal in the AM and IP peak periods. In the PM peak period there is a noticeable increase in option 01A-v2 and 02A-v2 scenarios to 16.4 and 12.7 PCU Hrs / Hr, however this is not deemed excessive.

Objective 11

Objective 11 was to assess overall network operations. The KPIs assessed as part of this objective were total travel time, travel distance and average speed. Total travel time is the total amount of travel time summed for all trips made on the entire model network. The travel distance is the total distance travelled summed for all trips made on the network. The average speed relates to the average vehicle speed of traffic over the entire network.

The results of these KPIs are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). Option 02A/02B-v2 recorded the lowest total travel time and highest average speed in each of the three peak periods. Across the three peak period's, option 02A/02B-v2 recorded the lowest overall travel distance.

Objective 12

Objective 12 was to assess the environmental impact. The KPIs assessed as part of this objective were vehicle emissions in terms of Carbon Monoxide, Carbon Dioxide, Nitrous Oxides and Hydro Carbons. These are model network wide vehicle emissions resulting from the proposed scheme as modelled in the SATURN model. The results of these KPIs are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*). The results indicate that each of the proposed options have fewer emissions than the Do Nothing and Do Minimum with limited difference between them. However, the options with the least emissions were identified as Option 02A/02B-v2 and 01A/01B-v2.

Objective 13

Objective 13 was to assess the operational efficiency of the N15. The KPI assessed as part of this objective was the Volume/Capacity ratios of junctions on the N15 which are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

For each scenario the Volume / Capacity ratios along the whole of the N15 began at SATURN Node 51 (at *Cashelgarran*) and continued to Node 2 (at the N4/N16/N15 junction). Model Option 01A-v2 and 01A/01B-v2 have an additional node (Node 1101) used which is reflected in the assessment. Volume / Capacity ratios of less than 50% were coloured green, between 50% – 85% inclusive were coloured amber and over 85% were coloured red.

Across all scenarios most of the Volume/Capacity ratios of junctions on the N15 were under 50% with a small number of junctions between 50% - 85%. No junctions on the N15 had a Volume/Capacity ratio of over 85%.

It is worth noting that Option 01A/01B-v2 had four consecutive junctions with an amber Volume/Capacity ratio. Node 1101 (the roundabout junction with the Proposed N16 and N15), Node 18 (N15), Node 19 (N15) and Node 148 (N15) each recorded a Volume/Capacity ratio of between 52.8% and 67.0% in the 2047 PM peak model. Although these ratios are well within 100% it has been identified as the worst performing section of any model scenario with these four consecutive junctions experiencing congestion, albeit at no more than two thirds of the capacity available.

Objective 14

Objective 14 was to assess the operational efficiency of key city centre junctions. The KPI assessed as part of this objective was the Volume/Capacity ratios of the key city centre junctions which are

presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

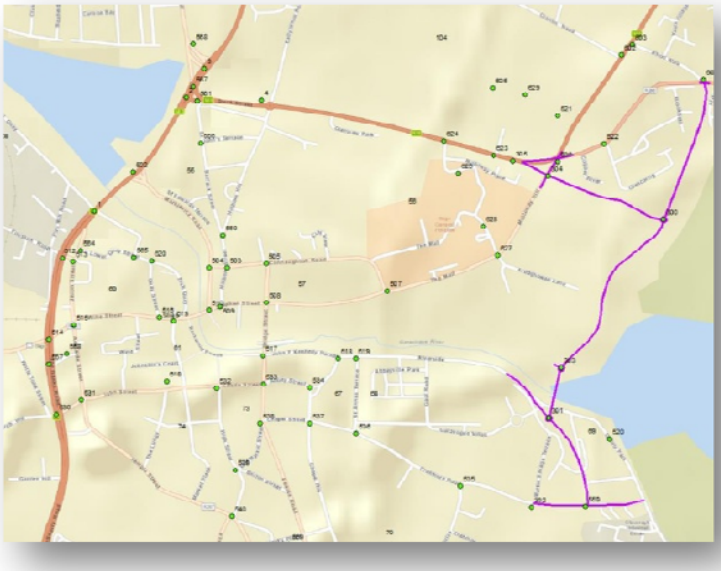
For ease of reading (within the aforementioned report), Volume / Capacity ratios of less than 50% were coloured green, between 50% – 85% inclusive were coloured amber and over 85% were coloured red.

Across all scenarios most of the Volume/Capacity ratios of the key city centre junctions were under 50% with a small number of junctions between 50% - 85% inclusive. One key city centre junction had a Volume/Capacity ratio of over 85% however this was in the 2047 AM Do Nothing scenario.

Overall, the worst performing junction is SATURN Node 619 which across all the options recorded a varying Volume/Capacity ratio of between 50% - 85% inclusive in the 2047 AM, IP and PM peaks. Node 619 is the signalised junction of the R292/O'Connell Street/Fish Quay in the centre of Sligo city.

Two further nodes on either side of node 619 also experienced Volume/Capacity ratios of between 50% - 85% inclusive in the Do Nothing AM and PM peak periods. However, both of these junctions (Nodes 510 and 516) decreased to a less than 50% Volume/Capacity ratio in each of the proposed option models. Node 510 is the priority junction on the east side of the R292 Hyde Bridge where it meets with the R286 Stephen Street. Node 516 is the priority junction of the R292 Wine Street and Quay Street.

Figure 10-5: Sligo City Centre Nodes



Objective 15

Objective 15 was to assess the impact on future Pedestrianisation of Sligo city centre. The KPI assessed as part of this objective was the traffic volume changes on links within Sligo city which are presented in the Traffic & Transport Section of Volume 2, Part A (*N16 Key Performance Indicator (KPI) Testing Technical Note (December 2016)*).

The assessment considered the changes in 2047 AADT flow across all the assessed scenarios when compared with the 2047 Do Minimum scenario. For ease of reading (within the aforementioned report), percentage difference changes of greater than +15% have been coloured dark red indicating a notable increase in vehicular traffic. Percentage difference changes of greater than -15% have been coloured dark green indicating a notable decrease in vehicular traffic. Smaller percentage changes of between 0% to +15%, and 0% to -15% have been coloured light red and light green respectively.

The most notable aspects from the aforementioned Objective 15 assessment include the following:

- The R870 Markievicz Road experienced a reduction in flow of approximately 52% in the northbound direction in Option 01A'01B-v2 and Option 02A/02B-v2. Similarly, the R870 Markievicz Road southbound also experienced a reduction in flow of between 25% - 28% in Option 01A/01B-v2 and Option 02A/02B-v2. However, the traffic model indicates that any benefit gained by Markievicz Road northbound in Option 01A/01B-v2 and Option 02A/02B-v2 has a negative impact on Holborn Street northbound as it experienced an increase in flow of between 48% - 50%. The reason for this shift in traffic patterns on Markievicz Road and Holborn Street in Option 01A/01B-v2 and 02A/02B-v2 is likely due to the fact that more traffic is using the Ballytivnan Road in these options. The proposed N15 upgrade in Option 01A/01B-v2 and 02A/02B-v2 appears to encourage some vehicles to use the alternative Ballytivnan Road and Elm Gardens to access the N15 northbound. This route avoids some of the congestion experienced on the N15 in these options, the signalised junction of Markievicz Road/N15 and the signalised junction of the existing N16/N15. This may explain the Markievicz Road traffic flow reduction and Holborn Street traffic flow increase in Option 01A/01B-v2 and 02A/02B-v2;
- The R286 Connaughton Road westbound (at the junction with City View) experienced an increase in flow of 39% in both the Option 05 and Option 08 models. It is believed that this is due to the fact that all traffic on the proposed N15 alignment in both these options enters the city centre via Molloway Hill and uses the R286 loop road to access the city centre. However, it is deemed that this increase on the R286 is not likely to adversely impact on city centre pedestrians as the R286 is designed to take vehicular traffic and is an area of relatively low pedestrian numbers when compared to other parts of the city centre (O'Connell Street, John Street, Grattan Street, Market Street and High Street). The R286 Connaughton Road according to the SEDP is a vehicular access to and from the city centre and so an increase in vehicular traffic on this route would not contravene the objectives of the SEDP;
- All other city centre links experienced smaller changes in flows of between +/-10%. Most of these smaller percentage changes were positive reductions in city centre traffic volumes.

Specific Objectives and KPIs Summary

To summarise the specific objectives and identify the higher scoring options a summary table has been created. Table 10-5 indicates that Options 02A/02B-v2, 05 and 08 (including option 12) similarly perform the best at complying with the specific objectives. Each of the options generally performs well against the objectives but in the circumstances in which it was deemed that an option did not comply with an objective these are outlined below.

In Option 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 the AADTs on local roads were lower than in the Do Nothing and Do Minimum but not to the same level as Option 05 and 08 which scored the best.

The highest number of junctions with a V/C ratio between 50% - 85% was in Option 01A/01B-v2. Options 02A/02B-v2, 05 and 08 recorded the least amount of junctions with a V/C ratio between 50% – 85%.

Option 01A-v2 and Option 02A-v2 recorded the highest over-capacity queuing in the 2047 PM peak period of 16.4 and 12.7 PCU Hrs / Hr. Although this level of over-capacity is not severe it is higher than the all the other options for the same period which ranged between 0 – 2.5 PCU Hrs / Hr.

There was minor variation in overall travel time in all of the proposed options, all of which were below that of the Do Nothing. Option 01A-v2 and 01A/01B-v2 recorded slightly higher travel distance than the other options. Average network speed was quite consistent across all the proposed options.

In terms of vehicle emissions each of the proposed options recorded fewer emissions than the Do Nothing and Do Minimum with Option 01A/01B-v2 and 01A/01B-v2 performing slightly better than the other options.

Option 01A/01B-v2 has four consecutive junctions which have a Volume / Capacity ratio of between 52.8% and 67.0%.

In terms of city centre Volume / Capacity ratios the worst performing junction was in the Do Nothing with a highest V/C ratio of 85.8% in the 2047 AM peak period. This was for the signalised junction of the R292/O'Connell Street/Fish Quay in the centre of Sligo city. None of the proposed options recorded a V/C ratio greater than 85%.

It was only Options 01A-v2 and 02A-v2 that maintained traffic volume changes within +/- 10% of the Do Minimum scenario. In other options greater decreases in street flows were experienced but often to the equal detriment of other street flows. It is thought that the proposed N15 upgrade roundabouts in Option 01A/01B-v2 and 02A/02B-v2 would encourage some vehicles to use the Ballytivnan Road and Elm Gardens to access the N15. The effect this would have in the city centre appears to decrease the traffic flow on Markievicz Road and increase it on Holborn Street as vehicles re-route to the Ballytivnan Road. Option 05 and 08 are likely to increase traffic flows on the R286 Connaughton Road, however this is a main traffic route (as stated in the SEDP) into the city centre from the existing N16 and not a heavily pedestrianised area when compared to other parts of the city centre which have a much higher pedestrian footfall.

10.3.1.2.3 *Traffic & Transport Conclusion*

The Key Performance Indicator Testing Technical Note has assessed a series of KPIs against the list of predefined objectives. From the summary table below it can be seen that Option 01A/01B-v2 has obtained the lowest rank with an overall score of 30 points. Option 01A-v2 scored better with 27 points, followed by Option 02A-v2 with a score of 26 points. Option 02A/02B-v2 scored better again with 25 points. However, the best ranked options were Option 5 and 8 with a score of 21 points.

Table 10-5: Initial KPI Testing

	Objective	KPI	Option 1A_S1A	Option 1B_S1B	Option 2A_S2A	Option 2B_S2B	Option 5	Option 8
3	Effectively cater for strategic traffic on N16	AADT on N16	3	3	3	3	1	1
		Select Link Analysis of traffic on N16 at Leitrim Boundary	3	3	3	3	1	1
4	Effectively cater for strategic traffic on N15 &	AADT on N15	1	2	1	2	1	1
		AADT on N4	1	1	1	1	1	1
5	Efficiently cater for strategic national traffic	Journey Times from N16 at Leitrim Boundary to N4/N16/N15 Junction	1	1	1	1	2	2
6	Efficiently cater for strategic traffic to sligo city gateway (NSS)	Journey Times from N16 at Leitrim Boundary to Sligo City Centre	1	1	1	1	1	1
7	Operational efficiency of N16	V/C ratios of junctions on N16	1	2	1	1	1	1
		Turn Delay at Junctions on N16	1	1	1	1	1	1
		Overall Score	12	14	12	13	9	9

	Objective	KPI	Option 1A_S1A	Option 1B_S1B	Option 2A_S2A	Option 2B_S2B	Option 5	Option 8
8	Ensure local roads cater for local movement	AADTs on local and regional roads within study area to north of Sligo City appropriate to local levels	2	2	2	2	1	1
9	Road network to cater for future traffic	Number of V/C ratios broken into bands throughout entire Sligo modelled network. E.g. number of junctions >85%, 50% - 85% and <50%	2	3	2	1	1	1
		GIS map indicating these locations	N/A	N/A	N/A	N/A	N/A	N/A
10	Reduce congestion on network	Transient and over-capacity queuing	2	1	2	1	1	1
11	Overall network operations	Overall travel time	1	1	1	1	1	1
		Overall travel distance	2	2	1	1	1	1
		Average network speed	1	1	1	1	1	1
12	Environment	Vehicle emissions	2	1	2	1	2	2
13	Operational efficiency of N15	V/C ratios of junctions on N15	1	2	1	1	1	1
14	Operational efficiency of key centre centre junctions	V/C ratios of key junctions within Sligo City Centre	1	1	1	1	1	1
15	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City	1	2	1	2	2	2
		Overall Score	15	16	14	12	12	12

	Option 1A_S1A	Option 1B_S1B	Option 2A_S2A	Option 2B_S2B	Option 5	Option 8
Overall Score	27	30	26	25	21	21

Table 10-6: Refined 'Feasible Route Option's – Traffic and Transport Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Overall	4	5	3	3	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	1	1

10.3.2 Road Engineering

10.3.2.1 Outline

Stage 1 – Part 1, of the Engineering Assessment has been set out in section 9.3 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible

Route Option's which followed. The lengths of the Refined 'Feasible Route Option's are as outlined in Table 10-7

Table 10-7: Refined 'Feasible Route Option's – Length

RRO	Travel Distance			
	Physical Works Length (m)	Additional journey TO N15 Junction with N16 (m)	Additional journey TO N16 Junction with R286/Molloway Hill (m)	Total Journey Distance (m)
Option 01A – v2	7,125	2,500	-	9,625
Option 01A/1B – v2	9,625	-	-	9,625
Option 02A – v2	8,180	1,180	-	9,360
Option 02A/02B – v2	9,360	-	-	9,360
Option 05	7,680	-	840	8,520
Option 08-v2	8,130	-	-	8,970
Option 12	8,270	-	840	9,110
Option 12 – v2	8,300	-	840	9,140

10.3.2.2 Assessment

The assessment was conducted in a similar manner to the Feasible Route Options assessment as already described in section 9.3.2.1. The Route Options preferences for the Refined 'Feasible Route Option's, in terms of horizontal alignment, vertical alignment, stopping sight distance, Full Overtaking Sight Distance and Constructability are outlined in the proceeding sections.

10.3.2.2.1 *Horizontal Alignment*

In term of 'Horizontal Alignment', all options were generally considered similar, with the exception of a 'Medium' preference ranking attributed to Route Option 12 – v2, due to the presence of a horizontal curve with a one step relaxation in design standards.

Table 10-8: Refined 'Feasible Route Option's – Horizontal Alignment Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	1	1	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	1	3
Overall	1	1	1	1	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	n/a	2

10.3.2.2.2 *Vertical Alignment*

The 'Vertical Alignment' assessment of the Refined 'Feasible Route Option's generally provided similar results to the 'Feasible Route Options'. Route options were consistently similar in the Central and Northern sections, while in the Southern section, relaxations required in the case of options 02A-v2, 02A/02B-v2 and 05 resulted in those options each receiving 'Medium' preference ranks.

Table 10-9: Refined Route Options – Vertical Alignment Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	2	2	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	2	2
Overall	2	2	2	2	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	2

10.3.2.2.3 *Stopping Sight Distance*

In the 'South' section; Options 01A-v2 and 01A/01B-v2 achieved best compliance (Very High Preference) with the standards. 'Low Preference' rankings are attributed to Options 02A-v2, 02A/02B-v2, 05 and 12, primarily as a result of 2 and 3 step relaxations in combination with the requirement for sightlines improvements in the vicinity of junction locations.

In the 'Central' section; Options 08-v2 and 12 achieved best compliance ('High Preference') with the standards. Option 05 was ranked 'Medium Preference' resulting from the fact, that it requires a 'One Step Relaxation' in design standards combined with a requirement for sight line improvements in the vicinity of junction locations (in order to ensure compliance with the 'Desirable Minimum' standard).

In the 'Northern' section, option 12 achieved best compliance ('Very High Preference') with the standards. Options 08-v2 and 12-v2 were ranked 'Medium Preference', resulting from the fact that they each require a 'One Step Relaxation' in design standards combined with each of them requiring sight line improvements in the vicinity of junction locations (in order to ensure compliance with the 'Desirable Minimum' standard).

Table 10-10: Refined Route Options – Stopping Sight Distance Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	4	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	3
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	3

10.3.2.2.4 *Full Overtaking Sight Distance*

In the 'South' section; Options 01A-v2 and 01A/01B-v2 provide the best overtaking values and were attributed 'Very High' preference scores; all the remaining options provide values between 15% and 30% and are accordingly attributed 'High' preference rankings. In the 'Central' section, each option had a value between 15% and 30% corresponding to 'High' preference ranks. In the 'North' section, all options, had overtaking values greater than 30% and were thus all given 'Very High' preference ranks.

Table 10-11: Refined 'Feasible Route Option's – Full Overtaking Sight Distance Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	2	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	1	1
Overall	1	1	2	2	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	2

10.3.2.2.5 *Constructability*

In the 'South' section; Options 01A –v2, 02A-v2, 12, 02A/02B-v2 and 05 are considered the most preferable ('Very High' and 'High' preference) from an ease of construction perspective. Option 01A/01B-v2 is considered more difficult to construct (due to online widening on the N15) and similar to the Feasible Route Option assessment is attributed a 'Medium' preference rank.

Constructability in the 'Central' section is generally consistent across route options with each option considered to be either 'Very High' or 'High' preference.

In the 'Northern' section, option 8-v2 is considered the best from an ease of construction perspective, while options 12 and 12-v2 are both considered more difficult ('Low Preference') due to their more online nature.

Table 10-12: Refined 'Feasible Route Option's – Constructability Ranking

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	3	1	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	1	ref 12
Middle	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	4	4
Overall	1	2	2	2	n/a	n/a	2	n/a	n/a	1	n/a	n/a	n/a	2	2

10.3.2.3 Assessment Conclusion

Based on the engineering assessment, Table 10-13 (Refined 'Feasible Route Option's) averages the results of the various geometry sub-criteria and provides a preference ranking for each route option. In general, all routes are considered to be 'Very High' preference, or 'High' preference overall.

Table 10-13: Engineering Summary – Refined 'Feasible Route Option's

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	2	2	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	2	3
Overall	1	2	2	2	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	2

10.3.3 Road Safety Impact Assessment

10.3.3.1 Outline

Stage 1 – Part 1, of the Road Safety Impact Assessment has been set out in section 9.3.3 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.3.3.2 Assessment

The assessment was conducted in a similar manner to the Feasible Route Options assessment as already described in section 9.3.3.2. The results of the overall assessment are outlined in Table 10-14. In conclusion, it is apparent that Option 01A/01B-v2 has the highest number of 'Very Low Preference' and 'Low Preference' ranks owning to aspects related to its Length, Junctions & Side Roads, Online Sections and impacts on the existing National & County Network; this is followed closely by Option 01A-v2, which also scores poorly under Length, Online Sections, Tie In South and impacts on the existing National & County Network.

Options 02A and 02A/B-v2 are both in the Medium Preference ranking category, however, in relation to these options the following is notable:

- ‘Low Preference’ ranks are recorded against:
  - Option 2A-v2 in relation to Length and impacts on the Tie In South;
  - Option 02A/B-v2 in relation to Junctions & Side Roads;

The best overall ranking options are Options 05, 08 – v2 and 12, each of which have an overall ‘High Preference’ rank. It is also notable, that there are no ‘Very Low Preference’ or ‘Low Preference’ ranks attributed to these options. Therefore it can be deduced that the best options from an overall RSIA perspective are 05, 08 – v2 and 12.

Table 10-14: Master RSIA Matrix Framework – Refined ‘Feasible Route Option’s

Elemental Criteria	RSIA 'Refined Route Options' Ranking						
	01A - v2	1A/01B - v2	OPT 2A - v2	2A/B - v2	OPT 5	OPT 8 - v2	OPT 12
Length	4	4	3	3	1	2	3
Junctions & Side Roads - Local Network Connections	2	5	1	4	3	3	3
Online Sections - Direct House Accesses	4	5	2	2	2	2	2
Tie In (South)	4	1	4	3	3	3	3
Impact on the existing National & County Network - including vulnerable road users	4	4	3	3	1	2	2
Score (incl. L)	4	5	3	3	1	1	1

10.4Economy Assessment (Options Comparison Estimate)

10.4.1 Outline

Stage 1 – Part 1, of the Economy Assessment has been set out in section 9.4 of this Route Selection Assessment. The following describes the consequential assessment of the Refined ‘Feasible Route Option’s which followed.

10.4.2 Assessment

The assessment was conducted in a similar manner to the Part 1 assessment as already described in section 9.4.1.2. Table 10-15 outlines the comparative analysis carried out for the Refined ‘Feasible Route Option’s.

10.4.2.1 Southern Section

The most expensive options to construct are generally options 02A-v2 and 02A/02B-v2. In this regard these options are given ‘Low’ preference ranks. ‘Medium’ preference options are considered to be Options 01A/01B-v2 and 05. The best ranked options in the Southern Section are Option 01A-v2 (‘Very High’ preference) followed by Options 08-v2 and 12 (‘High’ preference).

10.4.2.2 Central Section

The most expensive options to construct are generally options 02A-v2, 02A/02B-v2 and 05 (‘Medium’ preferences). All the other options are generally similar with ‘Very High’ preference ranks.

10.4.2.3 Northern Section

In the north section, option 12 is the best ranked option with a 'Very High' preference rank. All the other options are generally similar with 'High' preference ranks.

10.4.2.4 Total Section

The most expensive options to construct are generally options 02A-v2, 02A/02B-v2 (c. €27m) followed by options 01A/1B-v2, 05 and 8-v2 (c. €25m to c. €26m).

Overall, option 01A-v2 is the best ranked option (c. €23m) followed by option 12 (c. €24m).

Table 10-15: Refined 'Feasible Route Option's – Comparative Estimates

RRO	South			Central		North		Total				
	Approx Cost (€ Million)	N15 Dual Carriageway Cost	Preference Rank	Approx Cost (€ Million)	Preference Rank	Approx Cost (€ Million)	Preference Rank	Approx Cost (€ Million)	Length	N15 Dual Carriageway Cost	Rank	Preference Rank
Option 01A - v2	€ 9.69		1	€ 5.09	1	€ 8.27	2	€ 23.05	7.6	€ -	1	1
Option 01A/1B - v2	€ 12.49	€ 21.37	3	€ 5.09	1	€ 8.27	2	€ 25.86	8.6	€ 21.37	5	3
Option 02A - v2	€ 13.01		4	€ 5.64	3	€ 8.27	2	€ 26.92	8.2	€ -	6	4
Option 02A/02B - v2	€ 13.01	€ 21.37	4	€ 5.64	3	€ 8.27	2	€ 26.92	8.2	€ 21.37	6	4
Option 05	€ 11.75		3	€ 5.66	3	€ 8.27	2	€ 25.68	7.7	€ -	4	3
Option 08 - v2	€ 11.56		2	€ 5.05	1	€ 8.27	2	€ 24.87	8.2	€ -	3	3
Option 12	€ 11.56		2	€ 5.09	1	€ 7.57	1	€ 24.21	8.3	€ -	2	2

10.5 Environment Assessment

10.5.1 Socio Economic

10.5.1.1 Outline

Stage 1 – Part 1, of the Socio Economic assessment has been set out in section 9.5.1 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.1.2 Assessment

The Socio Economic assessment of the Refined 'Feasible Route Option's was conducted in a similar manner to the Feasible Route Options.

The relative ranking of the Refined 'Feasible Route Option's, represents a trade-off, of similar impacts at alternative locations. Options 01A-v2 and 01A/01B-v2 place additional traffic onto the existing N15 south to Cartron, adding to existing community severance at this location and impacting on the journey amenity of existing N15 traffic while leaving a proportion of traffic on the existing N16. Route Options 02A-v2 and 02A/02B-v2 do the same, but for a shorter length of the N15. In both cases, RRO 01A/01B-v2 and RRO 02A/2B-v2 provide for improvements to the existing N15 and improved journey amenity. However, both introduce new severance into Ballytivnan. Route Options 05, 08-v2 and 12 remove through traffic from the N16 without adding to traffic volumes on the N15, or severance at Cartron, but options 08-v2 and 12 do introduce some severance (or a journey detour) in the South Section for a large number of residences. Relative to options 08-v2 and 12, RRO 05 maintains existing severance at Doonally Bridge, but this is reduced relative to the existing level of severance. Table 10-16 outlines the results of the assessment.

Table 10-16: Refined 'Feasible Route Option's rankings (socio-economic)

Section	Refined Route Options														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	5	4	4	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	2	2
Overall	4	3	4	3	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	2	2

10.5.2 Property (other than Agricultural)

10.5.2.1 Outline

Stage 1 – Part 1, of the Non-Agricultural property assessment has been set out in section 9.5.2 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.2.2 Assessment

For the Southern section of the study area, the impact on non-agricultural property was deemed to be Minor Negative on Refined 'Feasible Route Option' 12 resulting in a High Preference. The impact was deemed to be Moderate Negative on Refined 'Feasible Route Option's 02A-v2, 02A / 02B-v2 and 05, resulting in a Medium preference. The impact was deemed to be Major on the remaining options with a Low preference on Refined 'Feasible Route Option's 01A-v2 (incl. a high impact on one house) and 01A/01B-v2 (incl. a high impact on two houses).

For the Central section, the impact on non-agricultural property was deemed to be Minor Negative on Refined 'Feasible Route Option' 05 resulting in a High preference. The impact is Moderate Negative on Refined 'Feasible Route Option's 08-v2, and 12 resulting in a Medium preference.

For the Northern section, the impact on non-agricultural property was deemed to be Minor Negative on Refined 'Feasible Route Option's 12 and 12-v2 resulting in a Medium preference. The impact is Moderate Negative on Refined 'Feasible Route Option's 08-v2, resulting in a Medium preference.

For the junction assessment at Collinsford on Refined 'Feasible Route Option' 12, there was no impact on non-agricultural property and the summary assessment was deemed to be Neutral for Junction Options 01, 02 and 03 resulting in a Very High preference.

Table 10-17: Overall summary of non-agricultural property assessment

Feasible Route Option	Southern Section		Central Section		Northern Section	
	Impact	Preference	Impact	Preference	Impact	Preference
1A	Major Negative	Low Preference	N/A	N/A	N/A	N/A
1A / 1B	Major Negative	Low Preference	N/A	N/A	N/A	N/A
2A	Moderate Negative	Medium Preference	N/A	N/A	N/A	N/A
2A / 2B	Moderate Negative	Medium Preference	N/A	N/A	N/A	N/A
5	Moderate Negative	Medium Preference	Minor Negative	High Preference	N/A	N/A

Feasible Route Option	Southern Section		Central Section		Northern Section	
	Impact	Preference	Impact	Preference	Impact	Preference
8	N/A	N/A	Moderate Negative	Medium Preference	Moderate Negative	Medium Preference
12	Minor Negative	High Preference	Moderate Negative	Medium Preference	Minor Negative	High Preference
12 V2	N/A	N/A	N/A	N/A	Minor Negative	High Preference
Junction Option	Junction 1		Junction 2		Junction 3	
	Impact	Preference	Impact	Preference	Impact	Preference
12 J3	Neutral	Very High Preference	Neutral	Very High Preference	Neutral	Very High Preference

Table 10-18: Non Agricultural Property – Preferences

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	4	4	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
Overall	3	3	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	2	2

10.5.3 Noise & Vibration

10.5.3.1 Outline

Stage 1 – Part 1, of the Noise & Vibration assessment has been set out in section 9.5.3 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.3.2 Assessment

10.5.3.2.1 *Potential Impact Rating*

The following outlines the PIR preferences, assessing the routes with a common commencement point from the existing N16's junction with the N4/N15 (as opposed to the physical design footprint bands):

Southern Section

Option 12 could be rated as the best ranked route option in terms of potential noise impact.

Central Section

Options 05 could be rated as the best ranked route option in terms of potential noise impact.

Northern Section

Options 12 and 08-v2 could be rated as the 1st and 2nd best ranked route options in terms of potential noise impact in the Northern Section.

10.5.3.2.2 *Assessment of changes in Traffic Flow*

The traffic flow data for all options indicate that there will be a very significant reduction in traffic volumes experienced on the existing N16 with the 'Central' and 'Northern' section of the proposed N16 realignment in operation. Future traffic volumes of less than 10% of the existing traffic volumes will be experienced on the existing N16 for all options except options 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2. In terms of changes in traffic flow data, the potential noise impact will be beneficial to noise sensitive receivers located in close proximity to the existing N16 alignment, where the proposed N16 realignment will be further removed from their property. However, in many areas of the 'Central' section and 'Northern' section of the proposed N16 realignment, the options do not significantly deviate away from the existing N16 alignment.

Significant changes in traffic flow on various road links of the existing and proposed road design network are predicted to occur for the various options in the 'Southern' section of the proposed N16 realignment for all the route options assessed.

10.5.3.2.3 *Assessment of Likely Need for Mitigation Measures*

A prediction of the likely noise levels at receivers in proximity to the Refined 'Feasible Route Option's has been undertaken using the *Calculation for Road Traffic Noise* (CRTN) calculation methodology and CadnaA noise modelling software. The predicted noise levels at receivers in proximity to the Refined 'Feasible Route Option's have been used to give an initial indication of where noise mitigation measures are likely to be necessary in order to achieve the design goal of 60dB L_{den} or less at each receiver.

Table 10-19: Number of receivers potentially requiring Noise mitigation.

Option No.	Possible Number of Receivers
Opt 1A-v2	9
Opt 1A+1B-v2	9
Opt 2A-v2	20
Opt 2A+2B-v2	20
Opt 5	6
Opt 8-v2	8
Opt 12-v2	6

10.5.3.2.4 *Assessment Conclusion*

Table 10-20 outlines the preference ranking from a Noise & Vibration perspective. This assessment is based on the three elements of Route Corridor Selection outlined in *The NRA Guidelines for the Treatment of Noise & Vibration in National Road Schemes*, including an assessment of potential impact rating (PIR) based upon property counts, a consideration of likely changes in traffic flow, and a review of the need for and difficulties associated with noise mitigation measures. This indicates option 05 (tying in with option 08-v2 in the north) to be the best overall option followed by option 12.

Table 10-20: Refined 'Feasible Route Option's rankings (Noise & Vibration)

Section	Refined Route Option													
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12
South	2	4	3	3	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	3	n/a	n/a	n/a	3
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2
Overall	2	3	3	3	n/a	n/a	1	n/a	n/a	3	n/a	n/a	n/a	2

10.5.4 Air Quality & Climate Change

10.5.4.1 Outline

Stage 1 – Part 1, of the Noise & Vibration assessment has been set out in section 10.5.4 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.4.2 Assessment

The Air Quality assessment was conducted in a similar manner to the Stage 1, Part 1 assessment as already described in the aforementioned section. The Refined 'Feasible Route Option's have been re-aligned and changes in emissions will be influenced by the changes in predicted traffic flow numbers. The slightly re-aligned Refined 'Feasible Route Option's resulted in changes in the number of properties within 50m of the route options. A Calculation of the Index of Overall Change in Exposure for each of the Refined 'Feasible Route Option's has allowed for a comparison of the overall impact on people of each route option to be carried out – this index assessment is provided in Volume 3, Part A, of the Route Selection Report.

Similar to the Feasible Route Options, there will be no exceedance of the Air Quality Standard Regulations as a result of any of the route options, nor, will there be any significant impacts (as a result of Air Quality) on sensitive ecosystems.

The Route Options preferences for the Refined 'Feasible Route Option's are outlined in the following table.

Table 10-21: Refined 'Feasible Route Option's rankings (Air Quality)

Section	Refined Route Option													
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12
South	2	4	2	2	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3
Overall	2	4	2	2	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3

10.5.5 Agricultural Property

10.5.5.1 Outline and Assessment

Stage 1 – Part 1, of the Agricultural property assessment has been set out in section 9.5.5 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

The impact assessment ranking and selection of preferences for the Refined 'Feasible Route Options' are based on the criteria as presented in Table 10-22.

Table 10-22: Overall summary of agricultural property assessment

Refined 'Feasible Route Option'	Southern Section		Central Section		Northern Section	
	Impact	Preference	Impact	Preference	Impact	Preference
01A	Moderate Negative	Medium Preference	N/A	N/A	N/A	N/A
01A / 01B	Moderate Negative	Medium Preference	N/A	N/A	N/A	N/A
02A	Major Negative	Very Low Preference	N/A	N/A	N/A	N/A
02A / 02B	Major Negative	Very Low Preference	N/A	N/A	N/A	N/A
05	Major Negative	Very Low Preference	Major Negative	Very Low Preference	N/A	N/A
08-v2	N/A	N/A	Major Negative	Low Preference	Moderate Negative	Medium Preference
12	Major Negative	Low Preference	Major Negative	Low Preference	Minor Negative	High Preference
12-v2	N/A	N/A	N/A	N/A	Minor Negative	High Preference
Junction Option	Junction 1		Junction 2		Junction 3	
	Impact	Preference	Impact	Preference	Impact	Preference
12 J3	Moderate Negative	Medium Preference	Minor Negative	High Preference	Moderate Negative	Medium Preference

For the Southern section of the study area, the impact on agricultural property was deemed to be Moderate Negative on Refined 'Feasible Route Option's 01A-v2, 01A/01B-v2 resulting in a Medium preference. The impact was deemed to be Major on the remaining options with a Low preference on Refined 'Feasible Route Option' 12 and a 'Very Low' preference on Refined 'Feasible Route Option's 02A ((incl. a high impact on 1 farm holding, and high impacts on 2 key dairy enterprises), 02A/02B-v2 (as per 02A) and 05 (incl. a high impact on 2 farm holdings, and a high impact on a key dairy enterprise).

For the Central section, the impact on agricultural property was deemed to be Major Negative all options resulting in a Low Preference on Refined 'Feasible Route Option's 08-V2 and 12 and a Very Low preference on Refined 'Feasible Route Option' 05. These rankings are generally as a result of high impacts on farm holdings including landtake, severance, farm houses and farm yards.

For the Northern section, the impact on agricultural property was deemed to be Minor Negative on Refined 'Feasible Route Option' 12 and 12-v2 resulting in a High preference. The impact is Moderate Negative on Refined 'Feasible Route Option's 08-v2 (incl. a high impact on one farm holding, including a high impact on a farm house) resulting in a Medium preference.

For the junction assessment at Collinsford on Refined 'Feasible Route Option' 12, the impact on agricultural property was deemed to be Minor Negative on Junction Option 02 resulting in a High preference. The impact was deemed to be Moderate Negative on Junction Options 01 and 03 resulting in a Medium preference.

Table 10-23: Agricultural Property – Preferences

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	3	3	5	5	n/a	n/a	5	n/a	n/a	ref 12	n/a	n/a	n/a	4	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	5	n/a	n/a	4	n/a	n/a	n/a	4	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
Overall	3	3	4	4	n/a	n/a	4	n/a	n/a	4	n/a	n/a	n/a	3	3

10.5.5.2 Mitigation

The design of Feasible Route Options has, where possible, avoided agricultural constraints such as dwelling houses, farmyard and key agricultural enterprises. The discounting of Feasible Route Option sections during the selection process, together with the design of modifications which were subsequently included in the Refined 'Feasible Route Option's has further considered such constraints.

The final design of the route alignment will include provision for a suite of measures to mitigate agricultural impacts such as land severance, impact on field drainage, interruption of water / power supplies / access to drinking points. It will include further measures dealing with the mitigation of construction and operation impacts on agriculture and non-agricultural property from noise, dust, visual impacts, etc.

For agricultural properties directly impacted by the compulsory purchase of lands, monetary compensation for land acquisition and disturbance will be agreed following the approval of the scheme.

10.5.6 Flora, Fauna & Fisheries

10.5.6.1 Outline and Assessment

Stage 1 – Part 1, of the Flora, Fauna & Fisheries Assessment has been set out in section 9.5.6 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed. The Flora, Fauna & Fisheries assessment was conducted in a similar manner to the Feasible Route Options assessment as already described in section 9.5.6.2.

10.5.6.1.1 *Flora and Fauna*

The Refined 'Feasible Route Option's sought to reduce the possibility of adverse effects upon high value ecological receptors at locations where Annex I habitats occurred. At these locations, modified design options have resulted in a refined prediction that no major adverse effects of significance are likely in terms of conflict with County Development Plan policies.

Route option 01A/B-v2 (or 01A-v2) and 12-v2 emerge as High preference options, while route options 02A/02B-v2, (or 02A-v2), 05 and 08-v2 were of Medium preference. These conclusions are summarised in Table 10-24.

10.5.6.1.2 *Fisheries*

The Doonally River is the most vulnerable receptor as the water body in which the river corridor is encroached upon by several route options, both in the form of channel crossings and proximity to the river channel.

Route option 01A/B v2 (or 01A-v2) emerges as a High preference option. Route options 02A/02B-v2, 05, 8-v2 and 12 were considered to be of medium preference, while route option 12- v2 was of Low preference. These conclusions are summarised in Table 10-25.

Table 10-24: ROA Preference (Flora and Fauna)

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	3	3	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Middle	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	1
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	2	2

Table 10-25: ROA Preference (Fisheries)

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	1	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	4	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	4
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	4

10.5.7 Hydrology & Hydrogeology

10.5.7.1 Outline and Assessment

Stage 1 – Part 1, of the Hydrology & Hydrogeology Assessment has been set out in section 9.5.7 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

The Preliminary Options Assessment, Part 2, identified the preference for option 01A as Medium, option 01B as Low, option 02A as Medium, option 02B as Low, route option 5 as Low, route option 08-v2 as Medium and options 12 and 12-v2 as Low.

Repeated verbatim from section 9.5.7.4 of this report, the following is the conclusion in relation to the Hydrology and Hydrogeology assessment:

> *In respect to the Hydrology/Hydrogeology there is little difference in the potential impact scale between the various route options considered for any of the three sections, with no profound impacts predicted and where significant impacts were identified mitigation measures were also identified that could reduce, or eliminate such impacts to moderate, slight and imperceptible. Significant hydrological and hydrogeological impacts in respect to potential water quality impact of construction runoff on the Glencar Lough (Ben Bulben, Gleniff and Glenade Complex SAC and pNHA), potential significant hydrogeological impacts to the Gortnagrelly petrifying spring Annex I habitat (National ecological importance), the Lugnagall Annex I habitat (National ecological importance) and moderate impact to the Drum East ecological receptor (Local higher value ecological importance) were identified. All other impacts in respect to water quality in receiving rivers and streams, impact to hydrogeological features and local well supplies and flood risk were rated as slight and moderate permanent impacts.*
>
> *In that respect the overall rating for the various road options had a limited range varying from medium to low preference with none identified clearly as either High, Very High, or Very Low preferences.*

Table 10-26: Refined 'Feasible Route Option's (Hydrology)

Section	Refined Route Option - Hydrology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	2	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
Overall	2	4	3	4	n/a	n/a	4	n/a	n/a	3	n/a	n/a	n/a	3	3

Table 10-27: Refined 'Feasible Route Option's (Hydrogeology)

Section	Refined Route Option - Hydrogeology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	4	4	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
Overall	4	4	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	4

Table 10-28: Refined 'Feasible Route Option's (Hydrology & Hydrogeology)

Section	Refined Route Option - Hydrology & Hydrogeology														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	3	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
Overall	3	4	3	4	n/a	n/a	4	n/a	n/a	3	n/a	n/a	n/a	4	4

10.5.8 Soils & Geology

10.5.8.1 Outline and Assessment

Stage 1 – Part 1, of the Soils and Geology Assessment has been set out in section 9.5.8 of this Route Selection Assessment. In terms of the Part 2 assessment, the following table summarises the preferences along each section, but in general from a Soils & Geology perspective, the preferred routes would be refined route 12 through the south section and Route 08-v2 through the Central section. Each of the routes were considered to have similar impacts in the northern section.

Table 10-29: Sectional Route Preferences

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	4	5	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	1	n/a	n/a	n/a	2	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
Overall	3	3	3	3	n/a	n/a	3	n/a	n/a	2	n/a	n/a	n/a	3	3

10.5.9 Landscape & Visual

10.5.9.1 Outline and Assessment

Stage 1 – Part 1, of the Landscape & Visual Assessment has been set out in section 9.5.9 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed. The route options preferences for the Refined 'Feasible Route Option's are outlined in the proceeding sections.

10.5.9.1.1 *Landscape Impacts*

Using both the predicted landscape sensitivity and the preliminary road design drawings the impacts of each option have been appraised and are outlined in summary format below.

Table 10-30: Landscape Character Impact Summary Overview of Refined 'Feasible Route Option's

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
Option 01A-v2				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 01A/01B-v2				
Southern	Sligo Lowland Agricultural LCA	Medium	Medium	Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium/High	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 2A-v2				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 02A/02B-v2				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 05				
Southern	Sligo Lowland Agricultural LCA	Medium	Low	Slight/Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 08-v2				
Southern	Sligo Lowland Agricultural LCA	Medium	Medium	Moderate Negative

Route Option	Landscape Character Area	Landscape character sensitivity	Magnitude of change in landscape resource	Predicted significance of landscape impact
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	High	Significant Negative
Option 12				
Southern	Sligo Lowland Agricultural LCA	Medium	Medium	Moderate Negative
Central	Sligo Lowland Agricultural LCA and Glencar Valley LCA	Medium & High	Medium	Moderate/ Significant Negative
Northern	Glencar Valley LCA	High	Medium	Moderate/ Significant Negative

10.5.9.1.2 *Visual Impact*

In a similar nature to the Stage 1, Part 1 Preliminary Options Assessment, the assessment of visual impacts upon residential properties for the refined options has been based upon a desktop quantitative analysis of dwellings within 300 m of the centre line of each option. The calculation of overall impact is based on the multiplication of the number of dwellings by 3, 2, 1 or 0.5 reflecting the severity of impact within 50 m, 50-100 m, 100-200 m and 200-300 m respectively.

Table 10-31: Index for Visual Impact on residential properties – Southern section

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index
Option 01A-v2	45	16	11	9.5	53	81.5
Option 01A/01B-v2	201	176	189	113.5	571	679.5
Option 02A-v2	12	40	69	46.5	186	167.5
Option 2A/02B-v2	141	180	231	127	622	679
Option 05	6	40	27	4.5	58	77.5
Option 08-v2	18	16	26	15	70	75
Option 12	18	16	26	15	70	75

Table 10-32: Index for Visual Impact on residential properties – Central section

Route Options	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index
Option 01A-v2	12	12	5	0	15	29
Option 01A/01B-v2	12	12	5	0	15	29
Option 02A-v2	9	2	9	0	13	20
Option 2A/02B-v2	9	2	9	0	13	20
Option 05	9	2	9	0	13	20
Option 08-v2	9	16	4	0	15	29

Route Options	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index
Option 01A-v2	12	12	5	0	15	29
Option 01A/01B-v2	12	12	5	0	15	29
Option 12	9	14	5	0	15	28

Table 10-33: Index for Visual Impact on residential properties – Northern section

Route Option	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index
Option 01A-v2	9	8	6	5	23	28
Option 01A/01B-v2	9	8	6	5	23	28
Option 02A-v2	9	8	6	5	23	28
Option 2A/02B-v2	9	8	6	5	23	28
Option 05	9	8	6	5	23	28
Option 08-v2	9	8	6	5	23	28
Option 12	9	8	3	5.5	21	25.5

Table 10-34: Index for Visual Impact on residential properties all routes combined

Route Options	0-50 m	50-100 m	100-200 m	200-300 m	Dwellings Total	Impact Index
Option 01A-v2	66	36	22	14.5	91	138.5
Option 01A/01B-v2	222	196	200	118.5	609	736.5
Option 02A-v2	30	50	84	51.5	222	267
Option 2A/02B-v2	159	190	246	132	658	859
Option 05	24	50	42	9.5	94	125.5
Option 08-v2	36	40	45	20	108	132
Option 12	36	38	34	20.5	106	128.5

10.5.9.1.3 *Conclusion of Refined 'Feasible Route Option's Assessment*

In summary when landscape impacts are considered overall there is a preference for Option 12. All other options are considered similar.

When visual impacts are considered overall there is a preference for Options 05, 08-v2 and 12, followed by option 01A-v2 and then 02A-v2. Options 01A/01B-v2 and 02A/02B-v2 are both less preferred.

When landscape and visual impacts are combined, there is a preference for Option 12 followed by options 05 and 08-v2.

Table 10-35: Landscape Preferences – Refined 'Feasible Route Option's

Section	Refined Route Option													
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12
South	1	2	1	1	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	2
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	4	n/a	n/a	n/a	3
Overall	3	3	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	2

Table 10-36: Visual Preferences – Refined 'Feasible Route Option's

Section	Refined Route Option													
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12
South	2	4	3	4	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	1	n/a	n/a	2	n/a	n/a	n/a	2
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	1
Overall	2	4	3	5	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	1

Table 10-37: Landscape & Visual – Refined 'Feasible Route Option's preferences

Section	Refined Route Option													
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12
Visual	2	4	3	5	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	1
Landscape	3	3	3	3	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	2
Overall	3	4	3	4	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	1

10.5.10 Archaeology & Cultural Heritage

10.5.10.1 Outline

Stage 1 – Part 1, of the Archaeology & Cultural Heritage Assessment has been set out in section 9.5.10 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.10.2 Assessment

The following table summarises the preferences along each section but in general from an archaeological perspective. The preferred routes would be Refined route 12 through the south section, Route 05 through the central section and either Route 08-v2 or Route 12 through the north section as they are marginally a better option than Route 12-v2 through here.

Table 10-38: Refined 'Feasible Route Option's Assessment (Archaeology)

Refined Route/Section	South	Central	North
1A-v2	Profound Impacts on CHC6 & CHC33; Moderate Impacts on CHC63 & CHC65; Slight Impacts on CHC3, CHC5 and CHC26	N/A	N/A
1A/1B-v2	Profound Impacts on CHC6 & CHC33; Significant Impacts on CHC32; Moderate Impacts on CHC56, CHC57, CHC59, CHC60, CHC61, CHC63 & CHC65; Slight Impacts on CHC3, CHC5 and CHC23	N/A	N/A
2A-v2	Significant Impacts on CHC41, CHC47 & CHC48; Moderate Impacts on CHC58, CHC59 &	N/A	N/A

Refined Route/Section	South	Central	North
	CHC63		
2A/2B-v2	Significant Impacts on CHC41, CHC47 & CHC48; Moderate Impacts on CHC56, CHC58, CHC59 & CHC63; Slight Impact on CHC23	N/A	N/A
5	Significant Impacts on CHC47; Moderate Impacts on CHC62 & CHC63; Slight Impacts on CHC76 & CHC77	Slight Impacts on CHC11 & CHC72	N/A
8-v2	N/A	Profound Impact on CHC11; Significant impact on CHC1, Slight Impact on CHC72	Profound impacts on CHC8 & CHC27; Slight Impacts on CHC52
12	Moderate Negative Impacts on CHC16, CHC28, CHC34, CHC62, CHC63 and CHC64	Profound impacts on CHC11 ringfort (Total removal); significant impacts on CHC1, megalithic tomb and slight Impact on CHC72	Profound negative impacts on CHC8 ringfort (partial removal) and CHC27 enclosure (partial removal); Slight negative impact on CHC52
12-v2	N/A	N/A	Profound negative impacts on CHC8 ringfort (partial removal), CHC10 ringfort (partial removal) and CHC27 enclosure (partial removal); Slight negative impact on CHC52

Table 10-39: Sectional Archaeology & Cultural Heritage (Preferences) of Refined 'Feasible Route Option's

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	5	5	2	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	1	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	5	n/a	n/a	n/a	5	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	5	n/a	n/a	n/a	5	5
Overall	5	5	3	3	n/a	n/a	3	n/a	n/a	4	n/a	n/a	n/a	4	4

10.5.11 Architectural Heritage

10.5.11.1 Introduction;

Stage 1 – Part 1, of the Architectural Heritage assessment has been set out in section 9.5.11 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.11.2 Conclusion's

10.5.11.2.1 *Sectional Assessment of Route Options*

The following table summarises the preferences along each section but in general from an architectural heritage perspective. The preferred routes would be refined route 01A-v2 through the South section, Routes 05, 08-v2 or 12 through the Central section and Route 8-v2 through the North section.

Table 10-40: Sectional split and significance of impacts in relation to Refined 'Feasible Route Option's

Refined Route/Section	South	Central	North
1A-v2	Moderate Impacts on AHC 15 and AHC 17	N/A	N/A
1A/1B-v2	Significant impacts on AHC 5 and AHC 39. Moderate Impacts on AHC 8, 9, 11, 12, 13, 15 & 17	N/A	N/A
2A-v2	Significant impacts on AHC 11, AHC 15, AHC 33 and AHC 37. Moderate impacts on AHC 10, 19 and 38.	N/A	N/A
2A/2B-v2	Significant impacts on AHC 11, AHC 15, AHC 33 and AHC 37. Moderate impacts on AHC 8, 9, 10, 19 and 38.	N/A	N/A
05	Significant impact on AHC 14, 15 & 35. Moderate impact on AHC 19	Significant Impact on AHC 33	N/A
8-v2	N/A	Significant Impact on AHC 33	Slight impact on AHC 24
12	Moderate impacts on AHC 6, 14, 15 & 16	Significant Impact on AHC 33	Moderate negative impact on AHC 24
12-v2	N/A	N/A	Moderate negative impact on AHC 24

Table 10-41: Sectional Architectural Heritage (Preferences) of Refined 'Feasible Route Option's

Section	Feasible Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	1	3	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	2	ref 12
Central	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
North	ref 8-v2	ref 8-v2	ref 8-v2	ref 8-v2	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	2	2
Overall	2	2	3	3	n/a	n/a	3	n/a	n/a	2	n/a	n/a	n/a	2	2

10.5.12 Urban Planning

10.5.12.1 Outline

Stage 1 – Part 1, of the Urban Planning Assessment has been set out in section 9.5.12 of this Route Selection Assessment. The following describes the consequential assessment of the Refined 'Feasible Route Option's which followed.

10.5.12.2 Assessment

The Urban Planning assessment was conducted in a similar manner to the Feasible Route Options assessment. Route Options 01A-v2, 01A/01B-v2, 02A-v2 and 02A/02B-v2 all receive similar preferences to their original option variants, as does option 05. The new Refined 'Feasible Route Option' number 12 is considered a similar option to the previous option 08 and this receives a 'High' preference rank.

Table 10-42: Sectional Urban Planning Assessment (Preferences) of Refined 'Feasible Route Option's

Section	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
South	3	3	4	4	n/a	n/a	3	n/a	n/a	Ref 12	n/a	n/a	n/a	2	n/a
Central	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
North	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Overall	3	3	4	4	n/a	n/a	3	n/a	n/a	2	n/a	n/a	n/a	2	n/a

10.6Recommendation on Options Refinement

10.6.1.1 South Section

10.6.1.1.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 10-43. In general, options 12 (Very High Preference) and 05 (High Preference) are the best scoring routes. Option 01A-v2 is next preferred (Medium Preference), while Options 02A-v2, 02A/02B-v2 and 01A/01B-v2 are least preferred.

In order to assist in the refinement of route options, Table 10-44 provides a general overview in relation to 'Very Low Preference' and 'Low Preference' ranks. It is apparent that the majority of these scores occur against options 01A/01B-v2, 02A-v2, 02A/02B-v2 and 01A-v2. It is also apparent that there are no 'Very Low Preference' or 'Low Preference' ranks recorded against option 12 in the South section.

Table 10-43: South Section: Full Scores Compilation

Disipine		Refined Route Options – South Section														
		1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Eng	Traffic & Transport	4	5	3	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
	Road Engineering	1	2	2	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	RSIA	4	5	3	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
Eco	Options Comparison Est.	1	3	4	4	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
Environmental	Socio Economic	5	4	4	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Non - Agri	4	4	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Noise & Vibration	2	4	3	3	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Air Quality	2	4	2	2	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Agriculture	3	3	5	5	n/a	n/a	5	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Flora and Fauna	1	1	3	3	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Fisheries	1	1	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	4	n/a
	Flora, Fauna & Fisheries	1	1	4	4	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Hydro	2	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Hydro-Geol	4	4	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Hydro and Hydro Geology	3	4	3	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Soils & Geology	4	5	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	3	n/a
	Landscape	1	2	1	1	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Visual	2	4	3	4	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
	Landscape & Visual	2	3	2	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Archaeology & CH	5	5	2	2	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
	Architectural H	1	3	4	4	n/a	n/a	4	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
	Urban Planning	3	3	4	4	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
Overall Index, Rank and Preference	Overall	45	58	51.5	51.5	n/a	n/a	42	n/a	n/a	ref 12	n/a	n/a	n/a	34	n/a
	STRAIGHT RANKING	3	6	5	4	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
	Preference	3	5	4	4	n/a	n/a	2	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a

Table 10-44: South - 'Very Low Preference' and 'Low Preference' ranks

Assessment	01A (v2)	01A/ 01B (v2)	02A/ 02B (v2)	02A/ 02B (v2)	03	04	05	06	07	08 (v2)	09	10	11	12	12 (v2)
RSIA	X	X			-	-		-	-	Ref 12	-	-	-		-
Traffic	X	X			-	-		-	-	Ref 12	-	-	-		-
Engineering					-	-		-	-	Ref 12	-	-	-		-
Options Estimate			X	X	-	-		-	-	Ref 12	-	-	-		-
Urban Planning			X	X	-	-		-	-	Ref 12	-	-	-		-
Socio-Eco	X	X	X		-	-		-	-	Ref 12	-	-	-		-
Noise & Vibration		X			-	-		-	-	Ref 12	-	-	-		-
Air Quality		X			-	-		-	-	Ref 12	-	-	-		-
Agriculture			X	X	-	-	X	-	-	Ref 12	-	-	-		-
Non-Agri	X	X			-	-		-	-	Ref 12	-	-	-		-
Ecology			X	X	-	-		-	-	Ref 12	-	-	-		-
Hydro & Hydro Geology		X		X	-	-	X	-	-	Ref 12	-	-	-		-
Soils & Geology	X	X	X	X	-	-	X	-	-	Ref 12	-	-	-		-
Landscape and Visual					-	-		-	-	Ref 12	-	-	-		-
Archaeology & Cultural Heritage	X	X			-	-		-	-	Ref 12	-	-	-		-
Architectural Heritage			X	X	-	-	X	-	-	Ref 12	-	-	-		-
Totals	6	9	7	7	-	-	4	-	-	Ref 12	-	-	-	0	-

10.6.1.1.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 10-45. In general, 'Low Preference' scores are seen to be recorded against options 01A/01B-v2 for Engineering and against options 02A-v2 and 02A/02B-v2 for Economics. Option 12 achieves the highest preference in the South section followed by Option 05 and Option 01A-v2.

This broadly shows a similar trend when compared against the 'Full Scores Compilation' assessment.

Table 10-45: South Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Engineering Average Rank	3	4	3	3	n/a	n/a	1	n/a	n/a	ref 12	n/a	n/a	n/a	1	n/a
Economics Average Rank	1	3	4	4	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a
Environment Average Rank	3	3	3	3	n/a	n/a	3	n/a	n/a	ref 12	n/a	n/a	n/a	2	n/a

10.6.1.1.3 *Refined 'Feasible Route Option' 13*

A recommendation arising from the Stage 1, Part 1, Preliminary Options Assessment (Section 9.6.1.5.4), was that an East/West link be considered as a complimentary component to Refined 'Feasible Route Option's' 05, or 12. The purpose of this link would be to provide an arterial connection between the N16 at the AbbVie roundabout and the N15. The Traffic and Transport Assessment subsequently carried out as part of the Stage 1, Part 2, Preliminary Options Assessment (Section 10.3.1) examined a number of Key Performance Indicators (KPI's) in relation to both of these route options. These KPI's and in particular; Objective 9 (Road network to cater for future traffic), objective 10 (Reduced congestion on network), objective 14 (operational efficiency of key City Centre junctions), objective 15 (Impact on future pedestrianisation of Sligo City Centre), demonstrate that; neither options 05, or 12 require the complimentary East/West link in order to operate efficiently.

In this regard, this option was not considered further as part of the current N16 Route Selection process. This is without any prejudice to the fact that such an option remains an attractive inter urban relief route, and as such may be considered further by the Local Authority as part of a separate local planning initiative at a later stage.

10.6.1.1.4 *South Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the Stage 1, Part 2 – Preliminary Options Assessment.

Discount Options

The following outlines options which have been recommended to be discounted following the Stage 1, Part 2, Preliminary Options Assessment.

Option 01A/01B-v2

It was recommended that option 01A/01B-v2 be discounted for the following reason:

- The extension to Option 01A-v2 which includes the online upgrade of the existing N15 increases the level of associated impacts. Considering the fact that this option (for the specific purpose of the N16 upgrade) does not offer any notable Traffic and Transport benefits over Option 01A-v2, it was considered that it should not proceed to the Stage 2 Project Appraisal Stage.

Option 02A-v2 and 02A/02B-v2

It was recommended that options 02A and 02A/02B-v2 be discounted for the following reasons:

- These options, do not offer any notable Traffic and Transport benefits over options 05 and 12. In this regard, considering the fact that they have a higher density of impacts, most notably in relation to the Options Comparison Estimate, Urban Planning, Agriculture and Architectural Heritage, it was concluded that they should not proceed to the Stage 2 Project Appraisal Stage.

10.6.1.2 Central Section

10.6.1.2.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 10-46. The results indicate a close correlation between the routes with each generally considered to be broadly similar overall.

In order to assist in the refinement of route options, Table 10-47 provides a general overview in relation to 'Very Low Preference' and 'Low Preference' ranks. These results also indicates a close correlation between the routes with option 05 having one 'Very Low Preference' rank, option 08-v2 with one 'Very Low Preference' rank and one 'Low Preference' rank, and option 12 having one 'Very Low Preference' rank and two 'Low Preference' ranks.

Table 10-46: Central Section: Full Scores Compilation

Disipine		Refined Route Options														
		Central Section														
		1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Eng	Traffic & Transport	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ref 12
	Road Engineering	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
	RSIA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ref 12
Eco	Options Comparison Est.	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
Environmental	Socio Economic	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
	Non - Agri	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Noise & Vibration	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Air Quality	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Agriculture	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	5	n/a	n/a	4	n/a	n/a	n/a	4	ref 12
	Flora and Fauna	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Fisheries	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Flora, Fauna & Fisheries	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Hydro	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Hydro-Geol	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
	Hydro and Hydro Geology	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	4	ref 12
	Soils & Geology	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	1	n/a	n/a	n/a	2	ref 12
	Landscape	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Visual	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	1	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
	Landscape & Visual	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Archaeology & CH	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	5	n/a	n/a	n/a	5	ref 12
	Architectural H	n/a	n/a	n/a	n/a	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12
	Urban Planning	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ref 12
Overall Index, Rank and Preference	Overall	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	35	n/a	n/a	35	n/a	n/a	n/a	36	ref 12
	STRAIGHT RANKING	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	1	n/a	n/a	1	n/a	n/a	n/a	2	ref 12
	Preference	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	ref 12

Table 10-47: Central Section - 'Very Low Preference' and 'Low Preference' ranks

Assessment	01A (v2)	01A/01 B (v2)	02A/02 B (v2)	02A/02 B (v2)	03	04	05	06	07	08 (v2)	09	10	11	12	12 (v2)
RSIA															
Traffic															
Engineering	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Options Estimate	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Urban Planning	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Socio-Eco	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Noise & Vibration	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Air Quality	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Agriculture	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	X	-	-	X	-	-	-	X	Ref 12
Non-Agri	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Ecology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Hydro & Hydro Geology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-	X	Ref 12
Soils & Geology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Landscape and Visual	Ref 08-	Ref 08-	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12

Assessment	01A (v2)	01A/01 B (v2)	02A/02 B (v2)	02A/02 B (v2)	03	04	05	06	07	08 (v2)	09	10	11	12	12 (v2)
	v2	v2													
Archaeology & Cultural Heritage	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-	X	-	-	-	X	Ref 12
Architectural Heritage	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-		-	-		-	-	-		Ref 12
Totals	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	1	-	-	2	-	-	-	3	Ref 12

10.6.1.2.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 10-48. In general, there is a minor difference apparent between the route options in relation to Economics, with options 08-v2 and 12 being more preferred than option 05.

Table 10-48: Central Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Engineering Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	2	n/a	n/a	2	n/a	n/a	n/a	2	ref 12
Economics Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	1	n/a	n/a	n/a	1	ref 12
Environment Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	3	n/a	n/a	3	n/a	n/a	n/a	3	ref 12

10.6.1.2.3 *Central Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the Stage 1, Part 2 – Preliminary Options Assessment.

Progress options to Stage 2 Project Appraisal

Considering the discreet nature of differences between the various route options, it was recommended that all options proceed to the Stage 2 Project Appraisal. Cognisance shall be had at that stage to discreet differences between the route options with particular regard to Hydrology and Hydrogeology, Options Comparison Estimate, Agriculture, Non Agricultural property and Archaeology & Cultural Heritage.

10.6.1.3 North Section

10.6.1.3.1 *Full Scores Compilation*

The results of the 'Full Scores Compilation' are outlined in Table 10-49. The results indicate a close correlation between the routes with each generally considered to be broadly similar overall.

In order to assist in the refinement of route options, Table 10-50 provides a general overview in relation to 'Very Low Preference' and 'Low Preference' ranks. These results also indicate a close correlation between the routes; Archaeology & Cultural Heritage is a 'Very Low Preference' rank for each of the route options. Route option 12-v2 also has a 'Low Preference' rank against it for Hydrology & Hydrogeology.

Table 10-49: North Section: Full Scores Compilation

Disipine		Refined Route Options														
		North Section														
		1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Eng	Traffic & Transport	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Road Engineering	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	2	3
	RSIA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Eco	Options Comparison Est.	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	1	1
Environmental	Socio Economic	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	2	2
	Non - Agri	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
	Noise & Vibration	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
	Air Quality	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
	Agriculture	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
	Flora and Fauna	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	1
	Fisheries	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	4
	Flora, Fauna & Fisheries	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	3
	Hydro	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
	Hydro-Geol	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
	Hydro and Hydro Geology	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	4
	Soils & Geology	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	3	3
	Landscape	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	4	n/a	n/a	n/a	3	3
	Visual	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	1	1
	Landscape & Visual	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	2
	Archaeology & CH	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	5	n/a	n/a	n/a	5	5
	Architectural H	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	1	n/a	n/a	n/a	2	2
	Urban Planning	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Overall Index, Rank and Preference	Overall	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	35	n/a	n/a	n/a	30	33
	STRAIGHT RANKING	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	2
	Preference	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	1	2

Table 10-50: North Section - 'Very Low Preference' and 'Low Preference' ranks

Assessment	01A (v2)	01A/01B (v2)	02A/02B (v2)	02A/02B (v2)	03	04	05	06	07	08 (v2)	09	10	11	12	12 (v2)
RSIA							Ref 08								
Traffic							Ref 08								
Engineering	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Options Estimate	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Urban Planning	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Socio-Eco	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Noise & Vibration	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Air Quality	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Agriculture	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Non-Agri	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Ecology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Hydro & Hydro Geology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		X
Soils & Geology	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Landscape and Visual	Ref	Ref	Ref 05	Ref 05	-	-	Ref	-	-		-	-	-		

Assessment	01A (v2)	01A/01B (v2)	02A/02B (v2)	02A/02B (v2)	03	04	05	06	07	08 (v2)	09	10	11	12	12 (v2)
	08-v2	08-v2					08-v2								
Archaeology & Cultural Heritage	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-	X	-	-	-	X	X
Architectural Heritage	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		
Totals	Ref 08-v2	Ref 08-v2	Ref 05	Ref 05	-	-	Ref 08-v2	-	-		-	-	-		

10.6.1.3.2 *Averaging as per Framework Matrix Criteria*

The results of the 'Framework Matrix Criteria' averaging assessment are outlined in Table 10-51. In general, there is a minor difference apparent between the route options, in relation to Environment with option 12 being more preferable than option 12-v2.

Table 10-51: North Section: Simple Averaging as per Framework Matrix Criteria

Criteria	Refined Route Option														
	1A (v2)	1A/B (v2)	2A (v2)	2A/B (v2)	3	4	5	6	7	8 (v2)	9	10	11	12	12 (v2)
Engineering Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	2	3
Economics Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	2	n/a	n/a	n/a	1	1
Environment Average Rank	ref 8-v2	ref 8-v2	ref 5	ref 5	n/a	n/a	ref 8-v2	n/a	n/a	3	n/a	n/a	n/a	2	3

10.6.1.3.3 *North Section - Recommendations*

Arising from the foregoing, the following recommendations were made following the Stage 1, Part 2, Preliminary Options Assessment.

Progress options to Stage 2 Project Appraisal

Considering the discreet nature of differences between the various route options, it was recommended that all options proceed to the Stage 2, Project Appraisal. Cognisance shall be had at that stage to discreet differences between the route options with particular regard to Flora, Fauna & Fisheries and Hydrology & hydrogeology.

vii. Stage 2: Project Appraisal

11 Stage 2: Project Appraisal

11.1 Introduction

The refined numbers of Route Options arising from the Stage 1, Preliminary Options Assessment (Part 2), were subsequently assessed based on the following Common Appraisal Framework criteria headings:

- Economy;
- Safety;
- Environment;
- Accessibility & Social Inclusion;
- Integration; and
- Physical Activity

As already outlined in section 4, these criteria were used to measure and compare the ability of each particular route option to deliver the defined objectives.

The following Chapter of the Route Selection Report should be read in conjunction with Volume 6 (Stage 2, Project Appraisal, Multi Criteria Analysis) of the Route Selection Report. This chapter provides additional information in relation to the background to the Multi Criteria Analysis.

11.2 Appraisal Methodology & Scenarios

11.2.1.1 Economic Appraisal

The economic appraisal for the proposed scheme has been carried out using TUBA (Transport User Benefit Analysis) software. This uses SATURN model run outputs from the scheme assessment process resulting in a user benefit analysis.

In TUBA software, scheme data is extracted directly from the traffic models. The software uses AM, Interpeak and PM model runs from the Opening Year, the Design Year (+15 years) and the Forecast Year (+30 years) as inputs and applies these separately to the scenarios being assessed. This 30 year appraisal accounts for tidal flow and traffic growth over the lifetime of the scheme and affords a holistic economic appraisal assessment.

For these assessments the Net Present Value (NPV) and Benefit-Cost Ratio (BCR) will be calculated.

As the lifespan of the project will be significantly in excess of the 30 year appraisal period, a 'Residual Value' is calculated using TUBA which will assess benefits from year 30 onwards. Considering the generally green-field nature of the project, a residual value period of a further 30 years will be used.

11.2.1.2 Safety

Safety impacts comprise the change in road accidents and road user security, representing an examination of the number of lives which will be saved.

The Safety Assessment for the scheme has been conducted qualitatively at Phase 2 (Route Selection) though the results of a Road Safety Impact Assessment and a Stage F Road Safety Audit.

In addition to similar qualitative assessments as outlined above, the Safety Assessment for the scheme at Phase 3 (Design), will be conducted quantitatively though the use of the COBALT (Cost and Benefit to Accidents – Light Touch) computer program developed by the UK Department for Transport (DfT). An Irish specific version of the COBALT program has been developed by TII for use on road schemes in the Republic of Ireland and is referred to as COBALT – Ireland.

11.2.1.3 Environment

The environmental impacts of the project are those that remain after mitigation measures have been devised and included in project costs. They include *inter-alia* monetised impacts and non-monetised impacts.

11.2.1.4 Accessibility & Social Inclusion

Under this heading, the impacts of the road are assessed with respect to vulnerable groups and deprived geographic areas. The social infrastructure and deprived areas that are afforded greater access as a result of the road are identified and estimates are made of the population benefiting and the degree of access improvement

11.2.1.5 Integration

The proposal will connect regional hubs and gateways to support balanced regional development in gateways as defined in the National Spatial Strategy. This will provide significant benefits in terms of the strategic north-south/east-west corridor. Additionally, the EU have designated the Belfast/Sligo road as one of the east/west links forming part of the Trans European Road Network, recognising its strategic importance in linking the peripheral north-west of Ireland with Belfast and the northern eastern ports. The N16 forms an essential component in cross-border co-operation.

11.2.1.6 Physical Activity

The Physical Activity criterion considers the nature of physical activity impacts including impacts on particular groups of road users such as pedestrians and cyclists.

An examination of Physical Activity related benefits was undertaken by the design team; however, due to the current low level of pedestrian/cyclist usage on the N16 and the difficulty establishing future usage which might arise from the new facilities, it was not considered appropriate to quantifiably factor this criterion into the Multi Criteria Analysis. However, potential qualitative benefits arising in terms of physical activity are outlined in section 11.4.6.

11.3Appraisal

11.3.1 Multi Criteria Analysis (MCA)

The MCA performance matrix for Stage 2, Project Appraisal is outlined in Table 11-1. This matrix which is inverted, from that which was used in the initial Stage 1, Preliminary Options Assessment (i.e. positive scores are high indexes as opposed to low ones) is a similar integer system to that recommended in *PE-PAG-0203, Project Appraisal Guidelines for National Roads Unit 7.0 - Multi Criteria Analysis.*

Table 11-1: TII PAG – MCA Criteria

Score Index	Impact Level
7	Major, or Highly Positive
6	Moderately Positive
5	Minor, or Slightly Positive
4	Not significant, or neutral
3	Minor, or slightly negative
2	Moderately negative

Score Index	Impact Level
1	Major or highly negative.

The assessment and its results are outlined in the aforementioned Volume 6 of the Route Selection Report.

By way of a reference to the initial 'Preliminary Options Assessment', the assessment within Volume 6 includes reference to the previous matrix undertaken during the initial stages of the Preliminary Options Assessment. The connection is provided via a reference key in the top right hand corner of each assessment commentary box and is explained in Table 11-2. Prior to the completion of the MCA, additional studies have been undertaken in relation to:

- Traffic and Transport Assessment;
- Economic Analysis; and
- Road Safety Assessments.

The results of these additional studies are outlined in the proceeding sections 11.3.2, 11.3.3 and 11.3.4.

Table 11-2: Reference Key to Stage 1, Preliminary Options Assessment

Reference Key	
Very High Preference	
High Preference	
Medium Preference	
Low Preference	
Very Low Preference	
Internal Key acronyms	
UB	Urban Planning
SE	Socio Economic
N&V	Noise & Vibration
AQ	Air Quality
N.AG	Non Agr
F&F	Flora & Fauna
F	Fisheries
H&H	Hydrology & Hydrogeology
S&G	Soils & Geology
L&V	Landscape & Visual
ACH	Archaeology & Cultural Heritage
AH	Architectural Heritage

11.3.2 Additional 'Traffic and Transport Assessment'

11.3.2.1 Key Performance Indicators

11.3.2.1.1 *General*

This section sets out the route selection assessment for the three Route Options which have progressed to the Stage 2 Project Appraisal stage. For a fuller appreciation of the results, the following reports contained within Volume 2 should be referred to:

- N16 Key Performance Indicator Testing Technical Note (December 2016);
- N16 Route Selection Study, Final Report, May 2017

Each of the three options were refined in terms of the traffic growth matrices used from the TII NTpM forecasts and the implementation of bespoke Speed Flow Curves. These refined models were then used to assess AADT, journey times, queuing, overall network operations and vehicle emissions. Once the scheme assessment was completed an economic appraisal was undertaken, the details of which are specified in Section 11.3.3 of this report.

11.3.2.1.2 *Model Refinements*

At the end of the initial option sifting stage of the process, the design team made minor adjustments to Option 8 and named this refined option "Option 12". The only difference between Option 8 and Option 12 was the length of one section of road was 145m longer in Option 12. This refinement was coded into the model.

After the initial KPI Testing Technical Note was submitted, network coding refinements of the proposed schemes were programmed. At this stage, through discussions with the design team, it was deemed appropriate to undertake a slight revision to the loading of traffic growth matrices used in the emerging options taken forward, to better reflect the loading of demand from the high level TII NTpM forecasts onto the N16 network at a more disaggregate level. Following these discussions, matrix modifications were undertaken on the zones to the east of the N16, which is represented only by one large zone in the NTpM (6904). In particular, Zone 102 was identified as a low trip generator and was reduced to 10%. The remaining 90% was split evenly across Zone 100 and Zone 66 where trip origins and destinations are greater. These modifications were applied only to the traffic growth and not to the underlying calibrated matrices, therefore not affecting the robustness of the modelling, but adding a more realistic loading pattern to the proposed traffic growth received from the TII NTpM.

After the initial KPI and sensitivity KPI scheme assessments were completed the three emerging option models underwent further refinement by inserting a more bespoke Speed Flow Curve for the proposed N16 route alignments, from the "standard" ones used up to this point. The refinement of the Speed Flow Curve was undertaken by reducing the bendiness to 25 degrees/km in line with the proposed N16 alignments and by reducing the HGV rate to 6% to correlate with the HGV flow in the N16 models. These bespoke amendments increased the Speed Flow Curve capacity from 1463 to 1605 and provided a nominal increase in maximum speed from 90 km/h to 91 km/h. This Speed Flow Curve amendment now better represents the proposed N16 benefits of the three emerging options for which some further KPI testing was undertaken to assess AADT, journey times, queuing, overall network operations and vehicle emissions.

11.3.2.1.3 *AADT on the N16*

The 2047 AADT at various critical locations on N16 alignment are presented in Table 11-3. The locations of the N16 AADT values are illustrated in Figure 11-1 to Figure 11-4 showing the different option arrangements and configurations for the Do Minimum and the three emerging options considered.

It can be seen that in the Do Minimum traffic volumes increase on the approach to Sligo, but reduce slightly to the south of the N16 junction with the L-3407-22 due to traffic using the L-7422-0 as an alternative route to the N16.

Option 01A-v2 only shows similar patterns of traffic using the N16 at points 1 - 3 with a greater reduction in traffic at point 4 as it gets closer to the N15. This highlights that traffic demand on the N16 is focussed more within Sligo and results in this demand utilising the existing N16 route as an alternative to the proposed alignments.

Options 5 and 12 showed similar traffic patterns with traffic volumes on the proposed N16 alignments at points 1 – 3. Option 12 southbound traffic flow on the N16 is lower than Option 5 the closer it gets to Sligo, this is due to the larger number of vehicles diverting to Rathbraghan Park and Old Bundoran Road in this option when compared with Option 5. This diverting traffic was observed in the Select Link Analysis during the IP and PM peak periods and indicates that the longer N16 in Option 12 is less desirable for some trips during most of the day. The Option 5 two-way flow on the N16 increases as it gets closer to Sligo. This demonstrates that Option 5 generally caters for the demand to Sligo, with limited use of the alternative routes to the N16. Option 5 caters for the highest demand levels of the three emerging options.

Table 11-3: Refined Models – N16 2047 AADT Comparisons

Map Reference	Direction	N16 2047 AADT (Per Direction)			
		DM	Opt 1A-v2	Opt 05	Opt 12
1	NB	1839	1839	1839	1839
1	SB	1813	1813	1813	1813
2	NB	1839	1839	1839	1839
2	SB	1813	1813	1813	1813
3	NB	1738	1839	1784	1773
3	SB	1723	1813	1743	1741
4	NB	2623	450	1724	2155
4	SB	2463	1536	1700	1644
5	NB	2452	-	2742	2323
5	SB	1469	-	2527	1745
6	NB	-	-	-	2531
6	SB	-	-	-	1822

Figure 11-1: SATURN Model Do Minimum

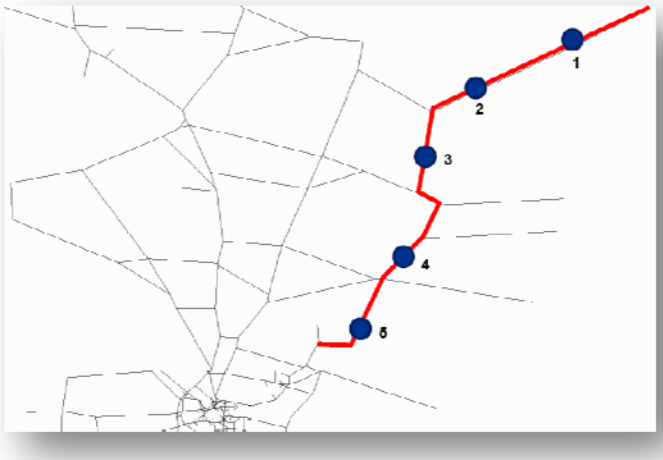


Figure 11-2: SATURN Model Option 01A-v2

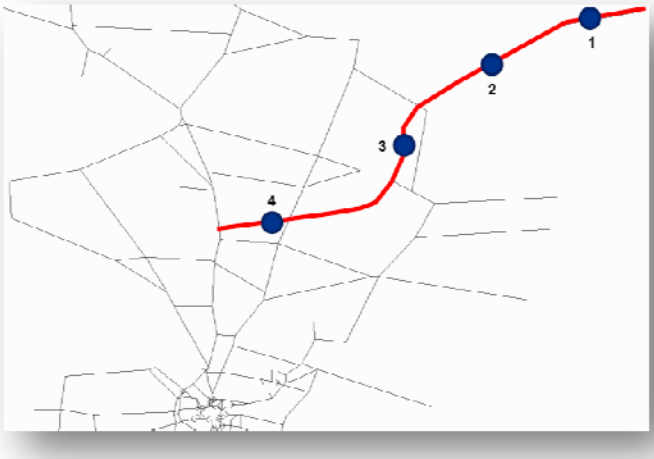


Figure 11-3: SATURN Model Option 05

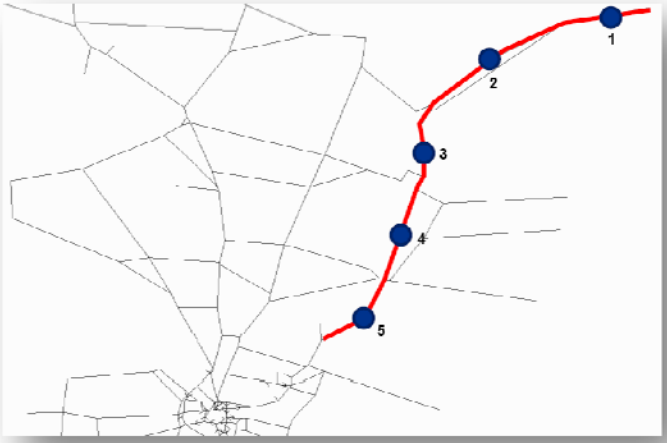
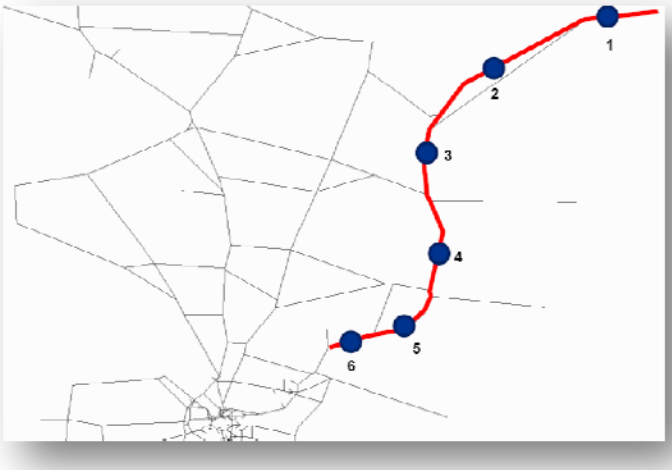


Figure 11-4: SATURN Model Option 12



11.3.2.1.4 *AADT on the N15*

The AADT values on the section of N15 adjacent to the N16 alignment are presented in Table 11-4 below. The locations of the N15 AADT values are illustrated in Figure 11-5 below. The section of the N15 in question, spans just north of where the proposed N16 intercepts it in the case of Option 01A-v2 to the signalised junction of the R291 Rosses Point Road.

It can be seen that on the N15 north of where the proposed N16 intercepts it (AADT 1), the northbound and southbound flows are relatively constant across all the scenarios.

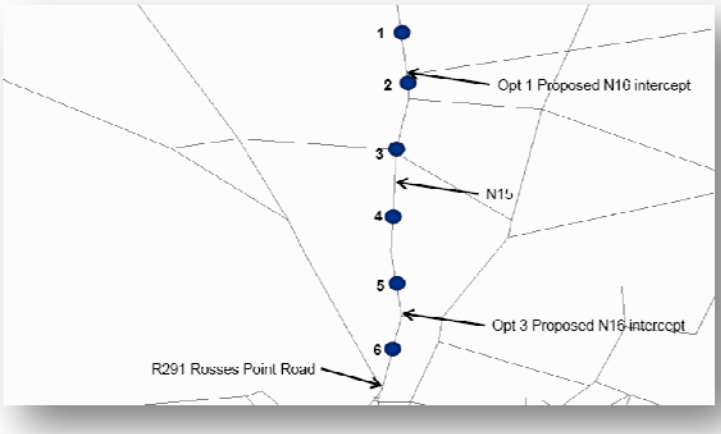
The northbound and southbound flows on the N15 immediately south of where the proposed Option 01A-v2 N16 intercepts it (AADT 2) have been included indicating that the southbound AADT is approximately 900 greater than the northbound in Option 01A-v2. Throughout all the reference points on the N15, Option 01A-v2 has the highest AADT owing to the proposed N16 intercepting the N15 in this option, while Option 05 and 12 show similar AADT levels with the Do Minimum scenario.

Table 11-4: Refined Models – N15 2047 AADT Comparisons

Map Reference	Direction	N16 2047 AADT (Per Direction)			
		DM	Opt 1A-v2	Opt 05	Opt 12
1	NB	8257	8299	8262	8242
1	SB	8107	8144	8119	8078
2	NB	-	8566	-	-
2	SB	-	9498	-	-
3	NB	8315	8562	8319	8306
3	SB	8128	9461	8146	8136
4	NB	7953	8257	8158	7968
4	SB	7669	8946	8105	7670
5	NB	8465	8670	8558	8389
5	SB	8437	9778	8888	8457
6	NB	7951	7973	7639	7761

Map Reference	Direction	N16 2047 AADT (Per Direction)			
		DM	Opt 1A-v2	Opt 05	Opt 12
6	SB	7935	9038	7806	8096

Figure 11-5: N15 AADT Locations



11.3.2.1.5 *AADT on the N4*

The AADT values at locations on the N4 are presented in Table 11-5 below. The locations of the N4 AADT values are illustrated in Figure 11-6 below.

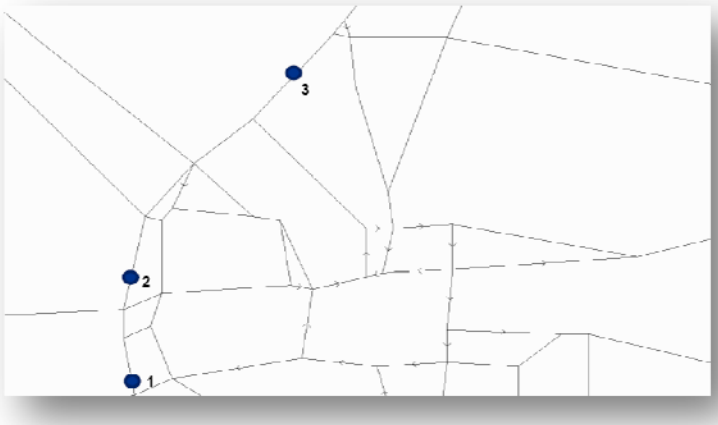
The locations of the AADTs are on the section of the N4 spanning above the signalised junction of Upper John Street to the south, and just below where the existing N16/Duck Street intercepts to the north.

Throughout the three reference points on the N4, Option 01A-v2, 05 and 12 all show similar AADT levels with the Do Minimum scenario, with Option 01A-v2 recording the highest AADT at each point.

Table 11-5: Refined Models – N4 2047 AADT Comparisons

Map Reference	Direction	N16 2047 AADT (Per Direction)			
		DM	Opt 1A-v2	Opt 05	Opt 12
1	NB	12072	13741	13574	13667
1	SB	9867	10740	10525	10713
2	NB	9605	10454	10390	10046
2	SB	10308	11534	11443	11604
3	NB	12992	13209	12796	12938
3	SB	15870	16024	14918	15473

Figure 11-6: N4 AADT Locations



11.3.2.1.6 *Journey Times from the Leitrim county boundary to the N4 / N15 / N16 junction*

This journey time route assessment was used to see how efficiently the different scenarios cater for strategic national road traffic and was assessed using journey times from the N16 at the Leitrim boundary to the N4/N16/N15 junction for the Do Minimum and the three emerging scheme options (Note: This assessment is independent of the Select Link Analysis).

The 2047 AM, IP and PM peak journey time comparisons for the Do Minimum and three emerging route options between the Leitrim county boundary and the N4/N16/N15 junction are presented in Table 11-6. As already outlined in section 10.3.1, Option 01A-v2 includes two journey times. The two journey times are when using the proposed N16 and using the existing N16. These indicate that the journey times when using the proposed N16 are between 2-3 minutes quicker than when using the existing N16 in Option 01A-v2. Overall, Option 01A-v2 recorded the shortest journey time (when using the proposed N16) followed by Option 05 and 12, respectively. It is has been noted that Option 05 whilst carrying the highest AADTs into Sligo City Centre still recorded journey times which were approximately 20 seconds faster than Option 12.

Although Option 05 and 12 have slightly longer journey times, as already mentioned in section 10.3.1, it is important to stress that the Select Link Analysis has indicated, that there is a low level of strategic traffic on the N16 travelling to the N4/N16/N15 junction. The Select Link Analysis shows that most of the southbound N16 flow in the AM period is travelling to Sligo City Centre.

Table 11-6: Refined Models - Journey Time Comparison for 2047 AM, IP and PM peak inbound

Scenario	Modelled Journey Times (mins)		
	Leitrim County Boundary to the N4/N16/N15 Junction		
	2047 AM	2047 IP	2047 PM
Do Minimum	09:44	09:28	09:39
Do Minimum Opt 1A-v2 (Proposed N16)	07:27	07:04	07:13
Do Minimum Opt 1A-v2 (Existing N16)	09:32	09:22	10:25
Do Minimum Opt 5	08:18	08:09	09:10
Do Minimum Opt 12	08:38	08:28	09:31

11.3.2.1.7 *Journey Times from the Leitrim county boundary to Sligo City Centre*

This journey time route assessment was used to see how efficiently the different scenarios cater for strategic traffic to Sligo City Gateway (NSS). This KPI was assessed using journey times from the N16 at the Leitrim boundary to Sligo city centre for the Do Minimum and the three emerging scheme options (Note: This assessment is independent of the Select Link Analysis).

The 2047 AM, IP and PM peak journey time comparisons for the Do Minimum and three emerging route options between the Leitrim county boundary and Sligo City Centre are presented in Table 11-7. Again, for information purposes, Option 01A-v2 includes two journey times. The two journey times are when using the proposed N16 and using the existing N16. These indicate that there is not much difference in the AM journey time to the city centre when using the proposed N16 or the existing N16 in Option 1A-v2. There is however, a greater journey time saving experienced in the 2047 IP and PM peak periods between the two routes, when compared to the Do Minimum.

Option 05 has the best journey times to the city centre but owing to the fact it also delivers the most traffic to the city centre this has created some delays in the city centre streets as they cope with this increase in traffic demand, thus increasing journeys times on the final links within the city centre. Overall, Option 05 recorded the shortest journey times in the AM and IP periods followed by Option 12 and Option 01A-v2. Option 05 has slightly longer journey times than Option 1A-v2 in the PM peak. This was due to Option 05 delivering the largest volume of traffic directly to Sligo City Centre, which resulted in a slight increase in delays southbound on Lake Isle Road towards the junction of Bridge Street and Stephen Street. The Select Link Analysis undertaken indicated that Option 05 catered effectively for the delivery of the largest volume of traffic to Sligo City Centre.

Table 11-7: Refined Models - Journey Time Comparison for 2047 AM, IP and PM peak inbound

Scenario	Modelled Journey Times (mins)		
	Leitrim County Boundary to the City Centre		
	2047 AM	2047 IP	2047 PM
Do Minimum	10:12	10:04	10:34
Do Minimum Opt 1a-v2 (Proposed N16)	09:51	09:07	09:25
Do Minimum Opt 1a-v2 (Existing N16)	09:59	09:55	10:47
Do Minimum Opt 5	08:47	08:45	09:42
Do Minimum Opt 12	09:13	09:11	09:47

11.3.2.1.8 *Network Queuing*

The KPIs assessed for this were transient and over-capacity queuing. Transient queuing relates to the overall level of queuing throughout the entire model network that occurs associated with typical under-capacity junction operation, but ultimately can be accommodated by the network. Over-capacity queuing relates to the level of queuing associated with junctions that have reached capacity.

The results of these KPIs are presented in Table 11-8 to Table 11-10 below. As can be seen the transient queuing recorded is fairly constant in each of the three peak periods (AM 218.2 – 224.3), (IP 156.4 – 165.8) and (PM 269.0 – 280.8). Overall, Option 12 has the least amount of transient queuing averaged across the three peak time periods.

Over-capacity queuing is minimal in each of the three peak periods (0 – 15.7 PCU Hrs / Hr).

Table 11-8: 2047 AM Network Queuing

Queue	2047 AM Congestion			
	DM	Opt 01A-v2	Opt 05	Opt 12
Transient Queues (PCU Hrs / Hr)	219.3	224.3	220.7	218.2
Over-Capacity Queues (PCU Hrs / Hr)	1.2	1.3	1.5	1.6

Table 11-9: 2047 IM Network Queuing

Queue	2047 AM Congestion			
	DM	Opt 01A-v2	Opt 05	Opt 12
Transient Queues (PCU Hrs / Hr)	165.8	157.2	156.4	156.4
Over-Capacity Queues (PCU Hrs / Hr)	0	0	0	0

Table 11-10: 2047 PM Network Queuing

Queue	2047 AM Congestion			
	DM	Opt 01A-v2	Opt 05	Opt 12
Transient Queues (PCU Hrs / Hr)	280.8	274.5	270.9	269.0
Over-Capacity Queues (PCU Hrs / Hr)	0.2	15.2	15.7	8.7

11.3.2.1.9 *Overall Network Operations*

The KPIs assessed for this were total travel time, travel distance and average speed. Total travel time is the total amount of travel time summed for all trips made on the entire model network. The travel distance is the total distance travelled summed for all trips made on the network. The average speed relates to the average vehicle speed of traffic over the entire network.

The results of these KPIs are presented in Table 11-11 to Table 11-13 below. Overall, Option 12 recorded the lowest total travel time and highest average speed across the three peak periods. While Option 5 recorded the lowest travel distance.

Table 11-11: 2047 AM Network Queuing

Queue	2047 AM Overall Network Operations			
	DM	Opt 01A-v2	Opt 05	Opt 12
Total Travel Time (PCU Hrs / Hr)	913.6	915.8	908.1	908.0
Travel Distance (PCU KMs / Hr)	45623.7	45616.8	45081	45586.5
Average Speed (Kph)	49.9	49.8	49.6	50.2

Table 11-12: 2047 IM Network Queuing

Queue	2047 IP Overall Network Operations			
	DM	Opt 01A-v2	Opt 05	Opt 12
Total Travel Time (PCU Hrs / Hr)	655.2	641.5	639.7	641.4
Travel Distance (PCU KMs / Hr)	32336.8	32312	32025.4	32340.4
Average Speed (Kph)	49.4	50.4	50.1	50.4

Table 11-13: 2047 PM Network Queuing

Queue	2047 PM Overall Network Operations			
	DM	Opt 01A-v2	Opt 05	Opt 12
Total Travel Time (PCU Hrs / Hr)	1039.7	1042.6	1030.9	1026.1
Travel Distance (PCU KMs / Hr)	49019	48923.3	48405.1	48877.4
Average Speed (Kph)	47.1	46.9	47.0	47.6

11.3.2.1.10 *Vehicle Emissions*

The KPIs assessed for this were vehicle emissions in terms of Carbon Monoxide, Carbon Dioxide, Nitrous Oxides and Hydro Carbons. These are model network wide vehicle emissions resulting from the proposed scheme as modelled in the SATURN model. The results of these KPIs are presented in Table 11-14 below which detail the proposed 2047 daily emissions for each option. The results indicate that each of the three emerging options have fewer emissions than the Do Minimum with Option 5 recording the least emissions, largely due to the fact that Option 5 provides the most direct route into Sligo City Centre.

Table 11-14: 2047 Daily Vehicle Emissions

Emission	2047 Daily Vehicle Emissions			
	DM	Opt 01A-v2	Opt 05	Opt 12
Carbon Monoxide (Kg)	3805	3739	3714	3725
Carbon Dioxide (Kg)	47342	47018	46558	46933
Nitrous Oxides (Kg)	992	981	976	978
Hydro Carbons (Kg)	692	681	676	678

11.3.2.1.11 *Summary of Assessment*

This stage of the assessment has considered AADTs, journey times, network queuing, overall network operations and vehicle emissions for each of the three emerging options that undergone model refinements. In terms of AADTs Option 5 performed the best for N16 traffic into Sligo City Centre, it also performed second best on the strategic journey time to the N4/N15/N16 junction and best on the journey time to Sligo City Centre. Option 12 performed the most resilient in terms of network queuing, total travel time and average speeds while Option 5 benefited from lower travel distance and vehicle emissions. This is likely due to the fact that Option 12 has more diverting traffic from the N16 to the Old Bundoran Road, spreading the impact, whereas Option 5 maintains most of the traffic on the N16 the closer it gets to Sligo. The longer N16 route in Option 12 appears less desirable for some trips to the city centre and the N15 during most periods of the day as reflected in the Option 12 AADT on the N16, however this diverting traffic has had a slightly positive impact on overall transient queuing, total travel time and average speeds in Option 12.

11.3.2.2 Sensitivity Tests

The KPI Sensitivity Testing Technical Note issued in January 2017 detailed the traffic assessment of the Do Minimum scenario and the three emerging options for three Sensitivity Tests in relation to the N16 scheme. For a fuller appreciation of the Sensitivity Test, the following report contained within Volume 2, Part A should be referred to:

- N16 Key Performance Indicator Sensitivity Testing Technical Note (January 2017);

The appropriate Sensitivity Tests undertaken were;

1. No Eastern Garvogue Bridge Sensitivity Test;
2. City Centre Pedestrian / Cycle Priority Sensitivity Test; and

11.3.2.2.1 *Sensitivity Test 1 - No Eastern Garvogue Bridge*

This sensitivity test considered the Do Minimum and three emerging scheme options without the proposed Eastern Garvogue Bridge in place. This sensitivity test was also undertaken for the N4-N15 Urban Improvement Scheme. The KPIs associated with this sensitivity test are listed below in Table 11-15. The KPIs were undertaken for the Do Minimum and the emerging three options in the 2047 forecast year only.

Table 11-15: No Eastern Garvogue Bridge Sensitivity Test 1 KPI's

No.	Objective	KPI
1	Effectively cater for strategic traffic	AADTs on N16, N15 and N4
2	Efficiently cater for strategic National Road traffic	Journey times from N16 at Leitrim Boundary to N4/N16/N15 junction
3	Efficiently cater for strategic traffic to Sligo City Gateway (NSS)	Journey times from N16 at Leitrim Boundary to Sligo City Centre
4	Road network to cater for future traffic	Number of V/C ratios broken into bands throughout Sligo modelled network E.g.: number of junctions >85%, 50%-85%, <50%
5	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City Centre

To summarise the Sensitivity Test 1 objectives and identify the higher scoring options a summary table has been created. Table 11-16 below indicates that Option 05 performs the best at complying with the Sensitivity 1 strategic objectives. Each of the options generally performs well against the objectives but in the circumstances in which it was deemed that an option did not score so well against an objective these are outlined below.

The AADT for the proposed N16 close to the junction with the N15 in Option 01A-v2 is quite low particularly in the northbound direction. This indicates that the proposed N16 is not well utilised in this option and that vehicles are using alternative routes. Options 05 and 12 both showed similar traffic patterns with traffic volumes on the proposed N16 alignments increasing closer to Sligo indicating that these routes generally cater for the demand to Sligo. However it was Option 05 that catered for the higher demand levels. AADT on the N15 was highest in Option 01A-v2 due to the proposed N16 intercepting the N15 to the north in this scenario.

The AM, IP and PM journey times for route one to the N4/N16/N15 junction (Objective 2) were approximately 9 minutes in the Do Minimum Sensitivity Test 1. The three emerging options all performed better with journey times of between 7-9 minutes. Although Option 05 and 12 have been scored below Option 01A-v2 in Objective 2 it is important to stress that the Select Link Analysis indicated there was a low level of strategic traffic on the N16 travelling to the N4/N16/N15 junction.

In Objective 3, the AM, IP and PM journey times for route two to Sligo city centre were approximately 10-11 minutes for the Do Minimum Sensitivity Test 1. The three emerging options all performed better with journey times of between 8-10 minutes, but it was Option 05 which recorded the quickest journey times to the city centre closely followed by Option 12.

In Objective 4 each of the emerging options recorded a low number of junctions with a V/C ratio between 50% - 85%. None of the options recorded a V/C ratio of greater than 85%. However, over the 3 peak periods it was Option 05 which recorded the least amount of junctions with a V/C ratio between 50% – 85%, closely followed by Options 12 and 01A-v2.

None of the emerging options recorded city centre traffic volume changes greater than +15% of the Do Minimum Sensitivity Test 1. Option 01A-v2 and 12 each had one link with a traffic volume change greater than -15% (both of which were on the R286 Connaughton Road). Overall, Sensitivity Test 1 traffic volumes for the 3 emerging options are relatively close to the Do Minimum traffic volumes.

Table 11-16: Sensitivity Test 1 – Objectives and KPI's Summary

	Objective	KPI	Option 1A_S1A	Option 5	Option 12
1	Effectively cater for strategic traffic	AADT on N16	3	1	2
		AADT on N15	1	2	2
		AADT on N4	1	1	1
2	Efficiently cater for strategic national traffic	Journey Times from N16 at Leitrim Boundary to N4/N16/N15 Junction	1	2	2
3	Efficiently cater for strategic traffic to Sligo City Gateway (NSS)	Journey Times from N16 at Leitrim Boundary to Sligo City Centre	2	1	1
4	Road network to cater for future traffic	Number of V/C ratios broken into bands throughout entire Sligo modelled network. E.g. number of junctions >85%, 50% - 85% and <50%	1	1	1
5	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City Centre	1	1	1
		Overall Score	10	9	10

11.3.2.2.2 *Sensitivity Test 2 - City Centre Pedestrian / Cycle Priority*

This sensitivity test considered the Do Minimum and three emerging scheme options with pedestrian and cycle priority measures included in Sligo City Centre. The KPIs associated with this sensitivity test are listed below in Table 11-15. The KPIs were undertaken for the Do Minimum and the emerging three options in the 2047 forecast year only.

The following objectives taken from the Sligo and Environs Development Plan lists the pedestrian and cycle priority measures included in Sensitivity Test 2;

1. Pedestrianised O'Connell Street (PED-1);
2. Pedestrian prioritisation and environmental improvements to include Castle Street, Grattan Street, Market Street, High Street and John Street (PED-2); and
3. Reduce traffic lanes crossing Markievicz Bridge southbound in City Centre from 2 to 1, providing footpath and cycle lane (eliminating need for additional bridge outlined in PED-8).

Table 11-17: City Centre/Cycle Priority Sensitivity Test 2 KPI's

No.	Objective	KPI
1	Effectively cater for strategic traffic	AADTs on N16, N15 and N4
2	Efficiently cater for strategic traffic to Sligo City Gateway (NSS)	Journey times from N16 at Leitrim Boundary to Sligo City Centre
3	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City Centre
4	Operational efficiency of key City Centre junctions	V/C ratios of key junctions within Sligo City Centre

To summarise the Sensitivity Test 2 objectives and identify the higher scoring options a summary table has been created. Table 11-18 below indicates that Option 01A-v2 and 05 perform the best at complying with the Sensitivity 2 strategic objectives. Each of the options generally performs well against the objectives but in the circumstances in which it was deemed that an option did not score so well against an objective these are outlined below.

The proposed N16 AADT close to the junction with the N15 in Option 01A-v2 is quite low particularly in the northbound direction. This indicates that the proposed N16 is not well utilised in this option and that vehicles are using alternative routes. Option 05 and 12 both showed similar traffic patterns with traffic volumes on the proposed N16 alignments increasing closer to Sligo indicating that these routes generally cater for the demand to Sligo. However it was Option 05 that catered for the higher demand levels. AADT on the N15 was highest in Option 01A-v2 due to the proposed N16 intercepting the N15 to the north in this scenario.

In Objective 2 the journey times for route two to Sligo city centre were approximately 10-11 minutes for the Do Minimum Sensitivity Test 2. The three emerging options all performed better with journey times of between 8-10 minutes, but it was Option 5 which recorded the quickest journey times to the city centre closely followed by Option 12.

In Objective 3, two of the emerging options recorded city centre traffic volume changes greater than +15% of the Do Minimum Sensitivity Test 2. Option 05 and 12 each had one link with a traffic volume change greater than +15% (both of which were on the R286 Connaughton Road).

For each of the emerging options Objective 4 identified two junctions as the worst performing in terms of city centre Volume / Capacity ratios. These junctions were the signalised junction of the R292 / O'Connell Street / Fish Quay and the priority junction of the R292 Wine Street and Quay Street, both adjacent to each other in Sligo city centre. However, the Volume / Capacity ratio of both junctions was within the 50% - 85% category in each emerging option, and so not deemed severe. None of the emerging options recorded a V/C ratio greater than 85% in Sensitivity Test 2.

Table 11-18: Sensitivity Test 2 – Objectives and KPI's Summary

	Objective	KPI	Option 1A_S1A	Option 5	Option 12
1	Effectively cater for strategic traffic	AADT on N16	3	1	2
		AADT on N15	1	2	2
		AADT on N4	1	1	1
2	Efficiently cater for strategic traffic to Sligo City Gateway (NSS)	Journey Times from N16 at Leitrim Boundary to Sligo City Centre	1	1	1
3	Impact on future pedestrianisation of Sligo City Centre	Traffic volume changes on links within Sligo City Centre	1	2	2
4	Operational efficiency of key City Centre junctions	V/C ratios of key junctions within Sligo City Centre	1	1	1
		Overall Score	8	8	9

11.3.3 Cost Benefit Analysis

11.3.3.1 Introduction

The economic appraisal for the proposed scheme was carried out using TUBA (Transport User Benefit Analysis) software. This uses SATURN model run outputs from the scheme assessment process resulting in a user benefit analysis.

In TUBA software, scheme data is extracted directly from the traffic models as outlined in Section 2 of Unit 6.3 in the PAG. The software uses AM, Inter peak and PM model runs from the Opening Year (2017), the Design Year (2032) and the Forecast Year (2047) as inputs and applies these separately for the two scenarios being assessed. The Inter peak was also used to approximate the weekend peak period. This 30 year appraisal accounts for traffic growth over the lifetime of the scheme.

The scenarios assessed were three Do Something options (Option 01A-v2, Option 05 and Option 12) compared against the Do Minimum. In the assessments the Net Present Value (NPV) and Benefit to Cost Ratio (BCR) were calculated for each option.

11.3.3.2 Key Appraisal Parameters and Assumptions

The economic appraisal has been undertaken using the Transport User Benefit Appraisal (TUBA) software, Version 1.9.7. TUBA carries out economic appraisal of transport schemes, based on outputs from transport models. An Irish version of the TUBA economics file has been received from TII and used for the appraisal.

The following key assumptions have been used in the economic appraisal:

- Scenario = N16_Scheme;
- Forecast = Central Growth;
- Traffic Model = SATURN;
- Present Value Year = 2011;
- Modelled years = 2017, 2032, 2047;
- Peak Periods = AM, IP, PM & WE (approximated by IP);
- Opening Year = 2017;
- Forecast Year = 2047;
- Appraisal Period = 30 years, from 2017 to 2047; and
- Discount rate = 5%.

11.3.3.3 Cost Estimates

This section outlines the base costs associated with the Do Minimum and Do Something schemes which have been used in the economic analysis.

11.3.3.3.1 *Do Minimum Costs*

A Do Minimum scenario maintenance cost of €3,111,750 provided by the Sligo National Roads Project Office have been included for the section of the N16 between the AbbVie roundabout and the county boundary with Leitrim. This represents the cost of maintaining the Do Minimum scenario when compared with the Do Something emerging options. This Do Minimum cost has been spread at 10% per year over the ten year period 2017 - 2026.

11.3.3.3.2 *Do Something Costs*

Options Comparison Estimate (OCE) base costs provided by the Sligo National Roads Project Office were input to the TII Phase 2 Option Selection spreadsheet as outlined in Unit 6.2 of the PAG. These costs for each of the three emerging options are detailed in Table 11-19 below.

Table 11-19: Options Comparison Estimate (OCE) Base Costs

Base Costs (Incl. VAT and Incl. Project-specific contingency)	Option 01A-v2	Option 5	Option 12
Mainline Length (km)	7.6	7.7	8.3
Underbridges (no.)	2	1	0
Riverbridges – Mainline (no.)	2	4	3
Riverbridges – Local Road (no.)	0	1	0
Main Contract Construction	€18,364,224	€18,800,512	€18,781,801
Main Contract Supervision	€815,385	€825,876	€888,046
Archaeology	€598,922	€628,851	€676,099
Advance Works and other contracts	€1,540,640	€1,560,461	€1,677,929
Residual Network	€288,563	€517,008	€456,891
Land & Property	€3,293,898	€5,246,946	€3,603,417
Planning and Design	€937,540	€949,602	€1,021,086
Subtotal	€25,839,171	€28,529,256	€27,105,270
Total Inflation Allowance	€1,581,564	€1,746,219	€1,659,059
TII Programme Risk	€1,291,959	€1,426,463	€1,355,263
Option Comparison Cost Estimate	**€28,712,694**	**€31,701,937**	**€30,119,593**

11.3.3.4 Economic Appraisal to Forecast Year 2047

Each of the three emerging options has been compared against the Do Minimum as part of the TUBA economic appraisal. This section of the report outlines the economic appraisal results for the three emerging options in the context of the Do Minimum scenario.

11.3.3.4.1 *Summary of Benefits*

The economic benefits associated with the preliminary proposed scheme options take account of:

- Travel time;
- Vehicle operating costs;
- Greenhouse gas emissions; and
- Wider Economic Benefits.

They do not include accident, reliability and wider economic benefits which are not included in the assessment of economic efficiency.

Scheme benefits are forecast over the entire appraisal period and discounted to the price base year of 2011. The Present Value of Benefits (PVB) is presented in Table 11-20 below.

Table 11-20: Present Value of Benefits for the N16 Scheme to Forecast Year 2047 (€000, 2011 values)

Element	Monetised Benefits, Scheme Option 01A-v2	Monetised Benefits, Scheme Option 05	Monetised Benefits, Scheme Option 12
Greenhouse Gases	7	9	11
Economic Efficiency: Consumer Users (Commuting)	1,336	6,548	5,163
Economic Efficiency: Consumer Users (Other)	2,395	9,540	7,595
Economic Efficiency: Business Users and Providers	3,046	8,721	7,039
Wider Economic Benefits (10% of Business Users and Providers)	305	872	704
Wider Public Finances (Indirect Taxation Revenues)	-8	-72	-41
Present Value of Benefits (PVB)	**7,081**	**25,618**	**20,471**

In this instance the PVB assessment has included wider economic benefits. As outlined in Section 4.1 of Unit 6.9 in the PAG business and freight user benefits are defined as the change in consumer surplus for the business and freight modes over all types of use benefit (time savings, vehicle operating cost savings, toll/fare changes, reliability benefits, etc).

The recommended appraisal method of the wider impact of increased output by firms is 10% of the business and freight user benefits. This calculation has been undertaken in row five of Table 11-20 and included in the value of the PVB for the three emerging options.

11.3.3.5 Economic Appraisal Results

The economic appraisal compares the proposed scheme costs against the forecast monetised benefits in order to determine overall value for money based on the BCR. The BCR is the ratio of the Present Value of Benefits to the Present Value of Costs, i.e. PVB/PVC. The Net Present Value (NPV) represents the difference between the Present Value of Benefits and the Present Value of Costs, i.e. PVB minus PVC.

Table 11-21 summarises the total benefits, total costs and provides the NPV and BCR for the proposed scheme.

Table 11-21: Present Value of Benefits for the N16 Scheme to Forecast Year 2047 (€000, 2011 values)

Element	Option 01A-v2	Scheme Option 05	Scheme Option 12
Present Value of Benefits (PVB)	7,081	25,618	20,471
Present Value of Costs (PVC)	22,887	25,827	24,140
Net Present Value (NPV)	**-15,806**	**-209**	**-3,669**
Benefit to Cost Ratio (BCR)	**0.309**	**0.992**	**0.848**

The results of the appraisal indicate that Option 01A-v2 and Option 12 do not generate an appropriate amount of PVB when compared to their associated PVC. Option 01A-v2 has a PVB of €7.081 million and a PVC of €22.887 million, which has indicated a BCR of 0.309. Option 12 has a PVB of €20.471 million and a PVC of €24.14 million, which has indicated a BCR of 0.848.

Option 5 performs better with a PVB of €25.618 million and a PVC of €25.827 million, which has indicated a BCR of 0.992.

It is important to note that this analysis does not take account of safety benefits or other environmental benefits.

11.3.3.6 Economic Appraisal including Residual Period to 2077

In accordance with Section 14 of PAG Unit 6.1, where the lifespan of infrastructure is significantly in excess of 30 years, it is necessary to acknowledge this in the scheme appraisal. Table 6.1.2 in Section 14 of PAG Unit 6.1 states that bridges, structures, tunnels, earthworks and other major investment in offline improvements should include a thirty year period for the calculation of residual value. The residual period is the thirty year period beyond the appraisal period. As the N16 scheme would be a long life major investment in an offline infrastructure improvement, the thirty year residual period from 2047 to 2077 has been included in the below appraisal.

Scheme benefits are forecast over the sixty year period (2017 to 2077) and discounted to the price base year of 2011. The Present Value of Benefits (PVB) which includes the wider economic benefits is presented in Table 11-22 below.

Table 11-22: Present Value of Benefits for the N16 Scheme – Including Residual Period to 2077 (€000, 2011 values)

Element	Monetised Benefits, Scheme Option 01A-v2	Monetised Benefits, Scheme Option 05	Monetised Benefits, Scheme Option 12
Greenhouse Gases	30	35	48
Economic Efficiency: Consumer Users (Commuting)	2,338	8,688	7,309
Economic Efficiency: Consumer Users (Other)	4,099	12,729	10,755
Economic Efficiency: Business Users and Providers	5,069	11,878	10,041
Wider Economic Benefits (10% of Business Users and Providers)	507	1,188	1,004
Wider Public Finances (Indirect Taxation Revenues)	-12	-86	-50
Present Value of Benefits (PVB)	**12,031**	**34,432**	**29,107**

Table 11-23 summarises the total benefits, total costs and provides the NPV and BCR for the scheme over the sixty year period to 2077.

Table 11-23: N16 Scheme Economic Appraisal Results – Including Residual Period to 2077 (€000)

Element	Option 01A-v2	Scheme Option 05	Scheme Option 12
Present Value of Benefits (PVB)	12,031	34,432	39,107
Present Value of Costs (PVC)	22,887	25,827	24,140
Net Present Value (NPV)	**-10,856**	**8,605**	**4,967**
Benefit to Cost Ratio (BCR)	**0.526**	**1.333**	**1.206**

The results of the appraisal including the residual period indicate that Option 5 has a PVB of €34.432 million, a PVC of €25.827 million and a BCR of 1.33.

11.3.3.7 Economic Appraisal Summary

Considering transport benefits alone (excluding safety and environmental economic benefits), the economic appraisal has shown that Option 01A-v2 and Option 12 will not provide economic benefits. Option 05, while not quite providing economic benefits, does perform the best with a NPV of -€0.209m and a BCR of 0.992 compared against the Do Minimum. The Net Present Value of Benefits will increase for each of these options upon the consideration of additional safety benefits which are

outlined in a conservative scenario in section 11.3.4.2; it is expected in this regard that upon these considerations, option 05 and option 12 would provide economic benefits.

The residual period appraisal to the year 2077 indicates that the further benefits of Option 05 increase the NPV to €8.605m and the BCR to 1.333. Similarly option 12's NPV and BCR will increase to €4.967m and 1.206 respectively.

11.3.4 Safety Appraisal

11.3.4.1 Road Safety Audit, Stage F

A Stage F, Road Safety Audit was undertaken by audit members from Kerry and Donegal NRDO's. The audit which covers options considered at Stage 1, Part 2; Preliminary Options Assessment Stage is included within Volume 4 of this Route Selection Report. The findings of the report have been considered by the design team and will where possible be incorporated in the design of the Emerging Preferred Route. The following quoted text, outlines the concluding statement to the Route Selection Report

Ranking of Route Options

This is a Stage F (Feasibility) Phase 1 Road Safety Audit.

The Safety Audit team carried out a full review of all relevant drawings and documents in relation to the developed route options. In addition the team visited the site. Some of the main safety considerations in comparing the routes at this preliminary stage included overall length, number, type and arrangement of junctions, general impact and interface with the existing network, potential design issues and other potential residual risks. A summary of some of the comparitive items reviewed is given below Table 11-24.

Table 11-24: Comparative advantages/disadvantages (non exhaustive/selected)[76]

OPTION	Ref.	Length(km) (Online)	No of Junctions	Clustering / Type and location of junctions	Interface with existing network /Road Closures
Red	R	7.6 (4.2)	6	Medium	8
~~Yellow~~	~~Y~~	~~8.2 (3.2)~~	~~6~~	~~low~~	~~12~~
Blue	Be	7.7 (1.5)	8	Medium	13
Brown	Bn	8.3 (1.5)	9	Medium	15
~~Black~~	~~Bk~~	~~8.2 (1.5)~~	~~9~~	~~High~~	~~14~~

The audit team has concluded that the route option proposals, as provided, rank as shown in the table below in terms of road safety. The ranking shown in Table 11-25 is purely a relative grading of the route options in respect to each other. All the proposed options represent a significant improvement to the existing poorly aligned N16 and a potential significant improvement to safety on that route.

[76] The ~~strikethrough's~~ outlined in Table 11-24 and Table 11-25 have been inserted by the author. These options although audited by the Road Safety Audit Team, did not proceed to the Stage 2, Project Appraisal Stage of the process.

Table 11-25: Option Ranking

OPTION	*Ref.*	*RANK*
~~*Yellow*~~	~~*Y*~~	~~*1*~~
Blue	*Be*	*2*
Red	*R*	*3*
Brown	*Bn*	*4*
~~*Black*~~	~~*Bk*~~	~~*5*~~

11.3.4.2 Safety, Economic Assessment

In order to assist in the qualitative assessment of the scheme in relation to 'Safety' and in the absence of a COBALT assessment which it is intended will be carried out at the next stage of the project development; the following outlines a generic assessment in relation to potential collision reduction monetary savings arising from the implementation of the scheme.

11.3.4.2.1 *Calculation of potential collision reduction values*

Table 11-26: Collision Recorded (2009 – 2016)

Severity	Collision No.
Fatal	2
Serious	1
Minor	9
Total	*12 no. total collisions over the 8 year period*

Collision rates per year may be expressed as the number of collisions over the observed period divided by the number of years assessed. The following table provides information on the collision rates per year:

Table 11-27: Collision Rates per Year

Severity	Collision Rates per year
Fatal	0.25
Serious	0.125
Minor	1.125
Total	*1.5 collisions per year*

The following table outlines the number of collisions which will occur along the existing route over the 30 year appraisal period if no improvement measures are undertaken:

Table 11-28: No. of Collisions over appraisal period

Severity	Collision No.
Fatal	7.50
Serious	3.75
Minor	33.75

Severity	Collision No.
Total	*45 no. of collisions over 30 year appraisal period*

Collision reduction factors arising from the proposed scheme have been calculated with reference to the Department of Environment publication '*A Guide to Road Safety Engineering in Ireland, 1996 DoE*'. These publications outline the collision savings predicted with new scheme improvements to be in the region of 30% - 40%.

In order to produce a conservative economic assessment of the likely collision reductions arising from the proposed scheme a 30% reduction factor in collisions over the appraisal period has been applied.

The table below outlines the reduction to collision numbers occurring from the proposed improvement measures.

Table 11-29: Reduction in collisions over appraisal period (2017 – 2047)

Severity	Reduction in Collision No.
Fatal	2.25
Serious	1.125
Minor	10.125

Information for the base costs associated for each collision type has been referenced from 'Road Collision Facts, 2012 RSA'. The following table sets out the collision costs in terms of severity:

Table 11-30: Collision base costs

Severity	Collision Cost
Fatal	€2,706,144
Serious	€361,531
Minor	€35,607

The table below provides a summary of the collision cost savings achieved over the 30 year appraisal period. The cost savings are expressed as the collision reduction multiplied by the associated collision cost.

Table 11-31: Collision cost savings over appraisal period (2017-2047)

Severity	Collision Cost
Fatal	€6,088,824
Serious	€406,722.38
Minor	€360,520.88
Total	*€6,856,067.26*

The total collision cost savings over the 30 year appraisal period amount to €6,856,067.26 in economic terms. For the current stage of the assessment this figure is considered a conservative estimate for each option.

11.4Multi Criteria Analysis Results

The results of the Multi Criteria Analysis are outlined in the proceeding Table 11-32 and Table 11-33. The following outlines the main factors considered to influence the comparison of route options, with particular regard to the satisfaction of objectives as set out in section 4 of this Route Selection Report.

11.4.1 Economy

The Economic criteria, was appraised under the headings of: *Efficiency and Effectiveness*, W*ider Economic Impacts*, *Transport Quality & Reliability* and *Funding Impacts*.

The measure of *Wider Economic Benefits* and *Funding Impacts* are considered to be similar for each of the route options.

In terms of *Efficiency and Effectiveness*, Option 05 is considered the best option achieving a Net Present Value of Benefits amounting to €25.618m and a Benefit to Cost Ratio of 0.992 in the Design Year of 2047. Option 12 achieved a Net Present Value of Benefits amounting to €20.471m and a Benefit to Cost Ratio (BCR) of 0.848 in the Design Year of 2047. It is expected that both these options should achieve a BCR greater than '1' once Safety is factored and in this regard, both are considered to achieve the scheme objectives.

Option 01A-v2 does not satisfy the desired objective as it will not achieve a Net Present Value of Benefits which will outweigh the Net Present Value of Costs.

In terms of *Transport Quality & Reliability*, each of the route options will increase average journey speeds on the rural section to over 90kph, thereby achieving the Level of Service D in the design year which is a required objective of the proposal. In a comparison of journey times between the Leitrim County Boundary and Sligo City Centre, Option 05 achieves the best saving of 01 minute and 09 seconds, compared with 52 seconds for option 12 and 23 seconds for option 01A-v2.

11.4.2 Safety

The Safety criteria, was appraised under the headings of *Collision Reduction* and *Security*. In terms of *Collision Reduction* a similar monetary saving is considered at this stage of the assessment to occur for each of the route options; however, considering the qualitative results of the Road Safety Impact Assessment and the Road Safety Audit (Stage F), Option 05 is considered overall to be a marginally better route, the primary reason for this is that it retains the existing N16 traffic and is 600m shorter than option 12.

In terms of *Security*, each of the options are considered to exhibit similar characteristics insofar as, the proposed new route will either include a dedicated cycle/pedestrian track, or will facilitate the use of the existing N16 as a suitable track. Direct domestic and agricultural tracks, will as far as practicable be removed from the national primary route and accommodated via the provision of new improved junction arrangements. In addition, results of the traffic model analysis, indicates that the provision of the scheme will not impact on future plans to pedestrianise sections of Sligo City which are objectives of the Sligo & Environs Development Plan.

Considering the foregoing, each of the route options are considered to achieve the objectives set out in section 4.1.1.

11.4.3 Environment

There were thirteen different disciplines considered in the Environmental Criteria. Overall, the Multi Criteria Analysis is slightly below the 'Minor, or Slightly Negative' Index for Options 01A-v2 and 05, and slightly above the 'Minor, or Slightly Negative' Index for option 12. This indicates that Option 12 is marginally the best option from an overall Environmental perspective. The variance of indexing is

generally as a result of Option 12 impacting to a lesser degree, on aspects relating to Urban Planning, Socio Economic, Agricultural and Non-Agricultural Property.

As each option could generally be considered to have an overall MCA Index of 'Minor, or Slightly Negative', it is considered that this maintains environmental impacts to as an acceptable level as is possible. In this regard each option is considered to achieve the Environmental objectives.

The design phase of the Emerging Preferred Route will improve the existing environmental conditions where that is possible. This will include *inter-alia:* improved water quantity and quality treatment measures, improved amenity benefits for those properties in the vicinity of the existing N16 and improved amenity benefits for vulnerable road users.

11.4.4 Accessibility & Social Inclusion

Accessibility & Social Inclusion is measured in terms of *Deprived Geographical Areas* and *Vulnerable Groups*. In both instances it is considered that all route options are similar overall and they each achieve the objectives to improve road based public transport and facilities for those without a car.

11.4.5 Integration

The Integration criteria, was appraised under the headings of: *Transport Integration, Land use Integration, Geographical Integration* and *Other Government Policy Integration*.

Each of the three route options are considered to achieve these objectives with similar results. In terms of *Transport Integration* each route option provides for a good strategic connection while they each also, via the provision of adjacent cycling/walking facilities, improve the connectivity of existing sustainable transport networks, particularly between Sligo and Glencar. In terms of *Land Use Integration* each option complies with the objective of the County Sligo Development Plan to realign and upgrade the existing N16, while also improving a Strategic Radial Corridor within the Border Regional Planning Guidelines (2010-2022). Each option also satisfies the objective in terms of *Geographical Integration*, as they each improve the N16 which is part of the comprehensive network of routes supporting the Trans-European Transport Network. They each also satisfy the objectives in terms of *Other Government Policy Integration* as they improve a 'strategic linking corridor' as defined in the National Spatial Strategy.

11.4.6 Physical Activity

The Physical Activity criterion considers the nature of physical activity impacts including impacts on particular groups of road users such as pedestrians and cyclists.

An examination of Physical Activity related benefits was undertaken by the design team; however, due to the current low level of pedestrian/cyclist usage on the N16 and the difficulty establishing future usage which might arise from the new facilities, it was not considered appropriate to quantifiably factor this criterion into the Multi Criteria Analysis.

However, there will be benefits arising (although currently immeasurable). These will include:

- Health benefits to pedestrians and cyclists, who take up or increase their levels of physical exercise, as a result of the improved new provisions as a result of the road infrastructure;
- A reduction in work related absenteeism as a result of increased physical activity;
- An improvement in journey ambience benefits as a result of the users' perception of reduced danger (a reduced fear of potential collisions/incidents) and improved quality of journey as a result of the proposal being considered. Existing users will experience these improvements as well as any new users who are attracted to the facility;
- The upgraded facility for cyclists and pedestrians is expected to have a lower cyclist and pedestrian incident risk associated with it than in the existing situation. For existing cyclists and pedestrians there is therefore likely to be a collision/incident reduction benefit

- Journey time may also be improved for some cyclists/pedestrians as a result of shorter journey times.

Table 11-32: Multi Criteria Analysis Results

N16 Sligo to County Boundary - MCA - Summary			
Sub Criteria	**Option 1A-v2**	**Option 05**	**Option 12**
	Index	**Index**	**Index**
Urban Planning	3.5	3.5	4
Socio Economic	4	4.8	4.7
Noise & Vibration	4	4.2	4.2
Air Quality	4.2	4	4
Agriculture	1.7	1.3	2.2
Non - Agri	1.7	2.3	2.7
Flora, Fauna & Fisheries	2.7	2.2	2.3
Hydro and Hydro Geology	2.25	2.25	2.5
Soils & Geology	3.3	2.7	3.3
Waste	3	3	3
Landscape & Visual	1.8	1.8	1.8
Archaeology & CH	1.5	2	1.7
Architectural H	2.3	2	2.3
Evironmental average Index	**2.77**	**2.77**	**2.98**
Sub Criteria	**Index**	**Index**	**Index**
Collision Reduction	6	6.5	6
Security	7	7	7
Safety average Index	**6.50**	**6.75**	**6.50**
Sub Criteria	**Index**	**Index**	**Index**
Efficiency and Effectiveness	2	4	3.5
Wider Economic Impacts	4	4	4
Transport Quality and Reliability	5	6	5.5
Funding Impacts	4	4	4
Economy average Index	**3.75**	**4.50**	**4.25**
Sub Criteria	**Index**	**Index**	**Index**
Deprived Geographical Areas	5	5	5
Vulnerable Groups	4	4	4
Accesibilty/Social Incl. agerage Index	**4.50**	**4.50**	**4.50**
Sub Criteria	**Index**	**Index**	**Index**
Transport Integration	6	6	6
Land use Integration	7	7	7
Geographical Integration	7	7	7
Other Government Policy Integration	7	7	7
Integration agerage Index	**6.75**	**6.75**	**6.75**

Table 11-33: Multi Criteria Analysis Results

Multi Criteria Analysis Summary			
Sub Criteria	Option 1A-v2	Option 05	Option 12
	Index	Index	Index
Evironmental average Index	2.77	2.77	2.98
Safety average Index	6.50	6.75	6.50
Economy average Index	3.75	4.50	4.25
Accesibilty/Social Incl. agerage Index	4.50	4.50	4.50
Integration agerage Index	6.75	6.75	6.75
Average	**4.85**	**5.05**	**5.00**

11.5Recommendation

11.5.1 Summary of Refined Route Options

Option 01A-v2

Option 01A-v2 which broadly corresponds with the 1996 Route Option, is considered to compare well against other options under the overall *'Environmental'* criteria, it is however considered to be slightly less desirable than Option 12. In terms of *'Safety'*, it is considered slightly less desirable than Option 05, but similar overall to Option 12. The option is also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

However, the route does not compare well against Option 05 or 12 in relation to *Economy* overall, and more specifically in relation to *Efficiency & Effectiveness* and *Transport Quality & Reliability*. The route option does not achieve a Benefit to Cost Ratio which is close to, or greater than '1'; therefore it has been concluded that it does not achieve the scheme objectives of an efficient network, this can largely be attributed to the fact that the route does not retain all Sligo bound traffic, south of its junction with the L-3406-0 (Drum Road).

Option 05

Option 05, is considered to compare well against other options under the overall *'Environmental'* criteria, it is however considered to be slightly less desirable than Option 12. In terms of *'Safety'*, Option 05 is considered to be slightly more desirable than Options 01A-v2, or Option 12. The option is also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

Option 05 is the most preferred option in relation to *Economy* overall. When safety is factored in, the route will achieve an overall Benefit to Cost Ratio which is greater than '1', thereby achieving the scheme objectives of providing an efficient network adding to the overall welfare of society.

Option 12

Option 12 in an overall *'Environmental'* perspective could be considered to be slightly more preferable than options 01A-v2, or option 05. In terms of *'Safety'*, it is considered slightly less desirable than Option 05, but similar overall to Option 01A-v2. The option is also considered to be similar to each of the other two options under the *Accessibility & Social Inclusion* and *Integration* headings.

In terms of Economy, and more specifically *Efficiency & Effectiveness* and *Transport Quality & Reliability* the route is slightly less desirable than option 05, however it will still achieve the scheme objectives once Safety is factored.

11.5.2 Recommendation for Further Assessment

Considering the foregoing, options 05 and 12 were considered overall to meet the scheme objectives and were both considered to be potentially viable routes. As option 01-v2 does not achieve the overall scheme objectives it was not considered further.

Prior to concluding on the selection of an Emerging Preferred Route, a direct Pair Wise comparison was undertaken on both these viable options. However, in advance of same, it was considered appropriate, arising from the environmental assessment set out in this Route Selection Report, to merge option 05 in the south with option 12 (north of *Castlegal* townland), this corresponds with the iterative nature of the process and allows to further reduce the potential for environmental impacts. In addition it ensures any bias is removed from a direct comparison of both options. This new route is labelled for the purposes of this assessment as option $05^{(S)}/12^{(N)}$.

11.6Pair Wise Comparison

The following sets out the results of the Pair Wise comparison between options $05^{(S)}/12^{(N)}$ and 12.

11.6.1 Economy

Efficiency and Effectiveness[77]

As already outlined in section 11.4.1; in terms of Efficiency and Effectiveness, under a 30 year appraisal period option $05^{(S)}/12^{(N)}$ achieves circa €5.15m benefits over option 12. The BCR for option $05^{(S)}/12^{(N)}$ is 0.992 (exclusive of safety) compared against 0.848 for option 12.

In order to as far as possible, correlate these differences into the Multi Criteria Analysis it was considered appropriate to undertake a pro-rata adjustment.

A score of '4' which corresponds to 'Not Significant, or Neutral' (exclusive of Safety) was considered appropriate for option $05^{(S)}/12^{(N)}$, considering the BCR established is almost '1'. The BCR of option 12 (0.848) is approximately 15% less than 0.992 therefore the Index of '4' was factored down to 3.42, this corresponds to 'Minor, or Slightly Negative, to Not Significant or Neutral'.

These scores are considered to be representative of the difference between the 2 options.

Wider Economic Impacts

Both options are considered similar in terms of Wider Economic Impacts. Each option is considered to be 'Not Significant, or Neutral' (Index of 4).

Transport Quality and Reliability

In terms of Transport Quality and Reliability; journey times (of N16 traffic between the County Boundary and the City Centre) were averaged over the AM, Interpeak and PM periods to reveal that $05^{(S)}/12^{(N)}$ achieved a saving of 72 seconds, compared with 53 seconds for option 12. Option $05^{(S)}/12^{(N)}$ in this regard is considered to be approximately 17 seconds quicker than option 12 in order to reach this destination.

In terms of MCA Indexing, similar to the Efficiency & Effectiveness criteria, a similar pro-rata exercise was carried out. The base score was considered to be option $05^{(S)}/12^{(N)}$ with an index of '6' corresponding to 'Moderately Positive'. On a conservative basis, it was considered that the minimum Index achievable is 'Not Significant, or Neutral' (Index of '4'); therefore on a prorata basis it was

[77] Although option $05^{(S)}/12^{(N)}$ will not require the underbridge structure associated with the L-3404-0; on a conservative basis it was decided not to factor down the Options Comparison Estimate for this option. This was in consideration of the fact that a farm underpass may be determined to be required for option $05^{(S)}/12^{(N)}$ at design stage – in this regard, this was considered to balance against the aforementioned underbridge.

calculated that the Index for option 12 is 5.47 (26%[78] less than an Index of '6') corresponding to 'Minor, or Slightly Positive, to Moderately Positive'.

These scores are considered to be representative of the difference between the 2 options.

Funding Impacts

Both options are considered similar in terms of Funding Impacts. Each option is considered to be 'Not Significant, or Neutral' (Index of 4).

11.6.2 Safety

Collision Reduction

In terms of Collision Reduction, although both options will provide significant benefits over the existing network, it is considered that option $05^{(S)}/12^{(N)}$ is slightly more desirable given that it is some 600m (circa 7%) shorter than option 12. This means effectively that traffic will spend less time on the network in the case of option $05^{(S)}/12^{(N)}$.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '6.5' corresponding to 'Moderately Positive, to Major, or Significantly Positive' while option 12 received a score '6' corresponding to 'Moderately Positive'.

These scores are considered to be representative of the difference between the 2 options.

Security

Both options are considered similar in terms of Security. Each option is considered to be 'Major, or Highly Positive' (Index of 4).

11.6.3 Environment

In terms of the Environment, disparities between the 2 route options occur generally in the area south of *Lugatober;* therefore the Pair Wise comparison is focussed on this particular section. Table 11-34 outlines numerically the comparison of the 2 options, while the proceeding sub sections provides commentary in relation to the various environmental criteria.

[78] Measured between an Index of '4' and '6'.

Table 11-34: Pair Wise Comparison, Environment, South

N16 Sligo to County Boundary - MCA - Summary				
Environment - South				
Criteria	Sub Criteria	Section	Option 12	Option 05/12
			Index	Index
Urban Planning	N/A	South	4.0	3.5
Socio Economic	N/A	South	4.0	4.5
Noise & Vibration	N/A	South	4.5	4.5
Air Quality	N/A	South	4.0	4.0
Agriculture	N/A	South	1.5	1.0
Non - Agri	N/A	South	3.0	3.0
Flora, Fauna & Fisheries	Flora & Fauna	South	3.0	3.0
	Fisheries		2.0	2.0
Hydro and Hydro Geology	N/A	South	3.0	2.5
Soils & Geology	N/A	South	3.0	2.0
Waste	N/A	South	3.0	3.0
Landscape & Visual	Landscape	South	2.0	2.5
	Visual		2.0	2.0
Archaeology & CH	N/A	South	2.0	1.5
Architectural H	N/A	South	2.0	1.5
Evironmental average Index			**2.9**	**2.7**

Urban Planning

In terms of Urban Planning; option 12 does not impact on the planned development areas in the Sligo and Environs Development Plan, while option 05 traverses/subdivides a small portion of planned urban areas.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '3.5' corresponding to 'Minor, or Slightly Negative, to Neutral, or Not Significant', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.

These scores are considered to be representative of the difference between the 2 options.

Socio Economic

In terms of Socio Economics; the main difference between the two options occurs in the area south of the L-7422-0/L-3407-22. Option 12 severs the existing N16 to the north, requiring the occupants of 18 properties to detour up to one kilometre north to a connection with the L-3407-22, while option $05^{(S)}/12^{(N)}$ introduces new severance for *Barroe* properties and maintains some existing severance at Doonally Bridge, although the introduction of a staggered junction between the L3407-0 and L3407-22 reduces this relative to the existing or do-nothing situation. Although, it may be possible to provide an additional access to the proposed route in the case of option 12, which would reduce the severance for the *Barroe* properties, it is considered that this would adversely impact the Safety and Collision Reduction Index score; in this regard such a design amendment has not been considered at this stage.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '4.5' corresponding to 'Neutral, or Not Significant, to Minor, or Slightly Positive', while option 12 received a score of '4' corresponding to 'Neutral, or Not Significant'.

These scores are considered to be representative of the difference between the 2 options.

Noise & Vibration

Both options are considered similar in terms of Noise & Vibration.

Air Quality

Both options are considered similar in terms of Air Quality.

Agriculture

In terms of Agricultural Property; In the case of option $05^{(S)}/12^{(N)}$, there will be a High impact on a farm holding on the L-3406-0 resulting from a direct impact on a farmyard comprising of animal housing and other facilities. There is a High impact on a Key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance and the proximity of the alignment to the farmyard. There is also a High impact on one farm holding in *Barroe* arising from landtake and severance.

In terms of option 12, there will be a High impact on five farm holdings in *Barroe, Faughts* and *Doonally* (Calry ED) due to landtake and severance. There will be a Medium impact on a key dairy enterprise in *Doonally* (Drumcliff East ED) due to landtake and severance.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1' corresponding to 'Major, or Highly Negative', while option 12 received a score of '1.5' corresponding to 'Moderately Negative, to Major, or Highly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Non – Agricultural Property

In terms of Non-Agricultural Property, there are only slight differences between the 2 options in the section south of *Lugatober*. In the case of option $05^{(S)}/12^{(N)}$ the more notable impacts are a Medium impact on a property in *Barroe* due to the impact on the property curtilage and existing access. There will be a Medium impact on a second property in *Barroe* due to the impact on the property curtilage and existing access.

In the case of option 12, there will be a Medium impact on a property (currently a Day Care Centre) in *Faughts* due to the impact on the property curtilage, existing property access and garden. There will be a Medium impact on a second property in *Doonally* due to the impact on existing access. There will be a Low impact on the remaining properties.

In terms of MCA Indexing, both options received an Index of '3' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

Flora, Fauna & Fisheries

Both options are considered similar in terms of Flora, Fauna & Fisheries.

Hydrology and Hydro Geology

Both route options are generally similar in terms of their impact on the Hydrological & Hydrogeological environment. A slight difference occurs in the case of option $05^{(S)}/12^{(N)}$ over option 12, as it may potentially result in the proposed road running almost parallel and in close proximity to the Willsborough stream channel and within the Floodplain for c. 200m, this is balanced against the fact that option 12 traverses an extensive area of pluvial flood risk.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.5' corresponding to 'Minor, or Slight Negative to Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Soils & Geology

Both route options are generally similar in terms of their impact on the Soils & Geology environment; that is with the exception of a more sizeable deficit of fill required for option $05^{(S)}/12^{(N)}$ over option 12.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2' corresponding to 'Moderately Negative', while option 12 received a score of '3' corresponding to 'Minor, or Slightly Negative'.

These scores are considered to be representative of the difference between the 2 options.

Waste

Both options are considered similar in terms of Waste activities.

Landscape & Visual

Both route options are generally similar in terms of their impact on the Landscape & Visual environment; that is generally with the exception of a long cut section in the south of option 12.

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '2.25' corresponding to just above 'Moderately Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

Archaeology & Cultural Heritage

In terms of Archaeology & Cultural Heritage; Option $05^{(S)}/12^{(N)}$ will result in Significant Negative Impacts on CHC47 (Mill Race) and Moderate Impacts on CHC62 & CHC63 which are both demesne landscapes. Option 12 will result in Moderate Negative Impacts on CHC16 (Ringfort), CHC28 (Ringfort), CHC34 (Enclosure), CHC62 (Demesne landscape), CHC63 (Demesne landscape) and CHC64 (Demesne landscape).

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

Architectural Heritage

In terms of Architectural Heritage; Option $05^{(S)}/12^{(N)}$ will result in a significant impact on AHC 14 (Demesne landscape), AHC 15 (Demesne landscape) and AHC 35 (Bridge). There will be a Moderate impact on AHC 19 (Mill Race). Option 12 will result in Moderate negative impacts on AHC 6 (Former Doonally School), AHC 14 (Demesne landscape), AHC 15 (Demesne landscape) and AHC 16 (Demesne landscape).

In terms of MCA Indexing, Option $05^{(S)}/12^{(N)}$ received a score of '1.5' corresponding to 'Moderately Negative to Major, or Highly Negative', while option 12 received a score of '2' corresponding to 'Moderately Negative'.

These scores are considered to be representative of the difference between the 2 options.

11.6.4 Accessibility & Social Inclusion

Deprived Geographical Areas

Both options are considered similar in terms of Deprived Geographical Areas (Minor, or Slightly Positive).

Vulnerable Groups

Both options are considered similar in terms of Vulnerable Groups (Not Significant, or Neutral).

11.6.5 Integration

Transport Integration

Both options are considered similar in terms of Transport Integration (Moderately Positive).

Land Use Integration

Both options are considered similar in terms of Land Use Integration (Major, or Highly Positive).

Geographical Integration

Both options are considered similar in terms of Geographical Integration (Major, or Highly Positive).

Other Government Policy Integration

Both options are considered similar in terms of Government Policy Integration (Major, or Highly Positive).

11.6.6 Physical Activity

Both options are considered similar in terms of Physical Activity.

Table 11-35: Multi Criteria Analysis Results – Following Pair Wise Comparison

N16 Sligo to County Boundary - MCA - Summary		
Sub Criteria	**Option 12**	**Option 05/12**
	Index	**Index**
Urban Planning	4	3.5
Socio Economic	4.7	4.8
Noise & Vibration	4.2	4.2
Air Quality	4	4
Agriculture	2.2	1.8
Non - Agri	2.7	2.7
Flora, Fauna & Fisheries	2.3	2.3
Hydro and Hydro Geology	2.5	2.25
Soils & Geology	3.3	2.7
Waste	3	3
Landscape & Visual	1.8	1.9
Archaeology & CH	1.7	2
Architectural H	2.3	2
Evironmental average Index	**2.98**	**2.86**

Sub Criteria	**Index**	**Index**
Collision Reduction	6	6.5
Security	7	7
Safety average Index	**6.50**	**6.75**

Sub Criteria	**Index**	**Index**
Efficiency and Effectiveness	3.42	4
Wider Economic Impacts	4	4
Transport Quality and Reliability	5.47	6
Funding Impacts	4	4
Economy average Index	**4.22**	**4.50**

Sub Criteria	**Index**	**Index**
Deprived Geographical Areas	5	5
Vulnerable Groups	4	4
Accesibilty/Social Incl. agerage Index	**4.50**	**4.50**

Sub Criteria	**Index**	**Index**
Transport Integration	6	6
Land use Integration	7	7
Geographical Integration	7	7
Other Government Policy Integration	7	7
Integration agerage Index	**6.75**	**6.75**

11.7Conclusion

The results of the MCA are outlined in Table 11-36. The 'Pair Wise' comparison outlined above has directly compared the viable route options which are considered to be option $05^{(S)}/12^{(N)}$ and option 12. In terms of the overall Multi Criteria Analysis assessment, Option $05^{(S)}/12^{(N)}$, achieved an overall index of 5.07 while option 12 received an overall index of 4.99. The main reasons for the more positive score for option $05^{(S)}/12^{(N)}$ relate to the fact that it is a shorter route by approximately 600m which has consequential benefits in term of Economy (Efficiency & Effectiveness, and Transport Quality & Reliability) and Safety.

In terms of environmental effects, both route options are considered to be generally similar in relation to Noise & Vibration, Air Quality, Non Agricultural Property, Flora, Fauna & Fisheries and Landscape & Visual. Option $05^{(S)}/12^{(N)}$ does carry slightly greater environmental impacts over Option 12 in relation to Urban Planning, Agriculture, Hydrology & Hydrogeology, Archaeology & Cultural Heritage and Architectural Heritage; however it is slightly more desirable than option 12 in terms of Socio Economics. It is also notable in relation to option $05^{(S)}/12^{(N)}$ that the most notable agricultural impacts occur on a circa 60 Ha Dairy Farm in *Doonally* townland. In addition, these same lands are classified as a Demesne Landscape in the Architectural Heritage Assessment. In the case of the impact on the aforementioned Dairy Farm, a monetary impact has been applied to the 'Options Comparison Estimate' of Option 05 which reflects the landtake, severance/injurious affection, disturbance and potential accommodation works – in this regard the impact is to a degree factored into the Transport *'Efficiency and Effectiveness'* assessment of the route. The Demesne as observed in a walkover of the lands (28/02/2017) by the Architectural & Cultural Heritage specialist has been modified for the purposes of agricultural use and possesses only small portions of intact landscape perimeter wall.

In this regard; it is proposed, considering the foregoing, that the route as depicted in Volume 5 (Option $05^{(S)}/12^{(N)}$) as Figures N16-RS-052 to 056, be progressed as the Emerging Preferred Route (EPR) for the N16. This EPR shall be encompassed by an 'Route Corridor' which is indicative only and does not represent project extents; this corridor will be used by the Planning Authority for the referral of planning applications to the TII and the National Roads Project Office. However, it is envisaged, insofar as is practicable, that any changes to the 'Emerging Preferred Route' during the design phase, will not extend outside of this 'Route Corridor'.

In addition, considering environmental sensitivities in 'Gortnagrelly', the 'Route Corridor' shall be extended to also cover option 12-v2; this will allow some scope at Environmental Assessment stage to reduce the environmental impacts in this area.

Table 11-36: Multi Criteria Analysis Results

Multi Criteria Analysis Summary		
Sub Criteria	**Option 12**	**Option 05/12**
	Index	**Index**
Evironmental average Index	2.98	2.86
Safety average Index	6.50	6.75
Economy average Index	4.22	4.50
Accesibilty/Social Incl. agerage Index	4.50	4.50
Integration agerage Index	6.75	6.75
Total	*24.95*	*25.36*
Average	**4.99**	**5.07**

11.8Public Consultation No. 04: Emerging Preferred Route'

A fourth Public Consultation commenced in the Clayton Hotel (previously Clarion Hotel), Sligo, on the 06th of June, 2017. The purpose of this consultation, which extended to the 21st of July, was to inform the public of the 'Emerging Preferred Route Corridor'.

Further submissions were encouraged from the Public during this process, which it was articulated, would assist in further refinements during the design phase. Submissions received during this stage have been retained on file and will be referred to during the proceeding design stage.